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BACKGROUND INFORMATION ON NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

PROPOSED AMENDMENTS TO STANDARDS FOR ASBESTOS AND MERCURY

Environmental Protection Agency

October 1974

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Amendments have been proposed for the national emission standards for asbestos and mercury that were promulgated April 6, 1973. This document presents the rationale for these amendments and an evaluation of their economic and environmental impacts.

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BACKGROUND INFORMATION ON NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS— PROPOSED AMENDMENTS TO STANDARDS FOR ASBESTOS AND MERCURY

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

October 1974

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1. INTRODUCTION

Section 112 of the Clean Air Act requires the Administrator to list hazardous air pollutants for which he intends to set emission standards and to then establish National Emission Standards for Hazardous Air Pollutants (NESHAP) for such substances. A hazardous air pollutant is defined as ". . .an air pollutant to which no ambient air quality standard is applicable and which in the judgment of the Administrator may cause, or contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness."

National emission standards for three hazardous air pollutants (asbestos, beryllium and mercury) were promulgated on April 6, 1973 (38 FR 8820). Clarifying revisions to these standards were promulgated on May 3, 1974 (39 FR 15396). In April 1973, the Environmental Defense Fund filed a petition for review of the standards with the United States Court of Appeals for the District of Columbia. This petition led to Agency investigation of additional sources of asbestos and mercury emissions. Appendix D presents a summary of the information sources consulted during the Agency's investigation. This investigation, together with information gained through enforcing the standards, has led to the Administrator's determination that the standards should be amended. Such amendments are being proposed in the Federal Register.

The preamble to the proposed amendments includes a brief explanation and rationale for the proposed actions. This document provides a more detailed discussion of the statements made in the preamble concerning the basis for the proposed amendments, which deal mainly with expanding the standards to cover additional major sources. Changes have also been made to improve the uniformity of enforcement and workability of the standards.

The basic approach used to develop the standards was to first identify ambient concentrations of the pollutants which were judged to provide an ample margin of safety to protect the public health. Allowable emissions were then derived from the safe ambient concentrations by using meteorological procedures. For asbestos, however, it is impossible to prescribe and enforce allowable numerical concentrations or mass emission limitations known to provide an ample margin of safety to protect public health, since no safe level has been identified. Although improvements have been made in asbestos measurement techniques since promulgation of the standard, and although the Agency has used these methods to estimate emissions from two large asbestos waste disposal sites in developing the proposed regulations, the techniques have yet to be sufficiently refined to provide a reliable basis for standard setting. Therefore, the promulgated standard for asbestos includes limitations on visible emissions or, as an option in some cases, the use of designated control equipment; requirements that certain procedures be followed; and prohibitions on the use of certain materials or of certain operations. The promulgated standard for mercury specifies an allowable mass emission rate which was derived from dispersion estimates as the rate which would protect against the violation of an average daily ambient concentration of 1 microgram per cubic meter averaged over a 30-day period.

A complete explanation of the basis and rationale for the asbestos and mercury standards that were promulgated on April 6, 1973, (38 FR 8820) may be found in the preamble to the regulation and in Background Information on Development of National Emission Standards for Hazardous Air Pollutants: Asbestos, Beryllium, and Mercury, EPA Publication No. APTD-1503, March 1973.

2. ASBESTOS: MANUFACTURING

SUMMARY OF PROPOSED AMENDMENT

There shall be no visible emissions of asbestos-containing particulate matter to the outside air from two additional manufacturing operations:

(1) The manufacture of shotgun shells.

(2) The manufacture of asphalt concrete.

As an alternative to the no-visible-emission standard, specified air cleaning methods may be used (see Appendix A).

RATIONALE FOR PROPOSED AMENDMENT

Asbestos is a significant raw material in the manufacture of numerous products. The standard promulgated April 6, 1973 (38 FR 8820), limits the emissions of asbestos from nine manufacturing operations. In the course of enforcing the standard for asbestos, the Agency discovered that the manufacture of shotgun shells utilizes a substantial amount of asbestos and observed that asbestos emissions were poorly controlled at some asphalt concrete plants. On the basis of a subsequent investigation of these two source categories (see Appendix D), the Administrator has determined that they are major sources of asbestos emissions and is therefore proposing that the asbestos standard be extended to include these two manufacturing operations.

Shotgun Shell Manufacture

The investigation into the manufacture of shotgun shells included a visit to the only shotgun shell manufacturing plant in the United States that is known to use commercial asbestos, and discussions with the plant operator and the Asbestos Information Association (AIA).

Asbestos is used to manufacture base wads for shotgun shells. The asbestos is mixed with wood flour and wax, and then pressed into base wads. The weight composition of the final mixture at the plant visited was 54 percent wood flour, 36 percent asbestos, and 10 percent wax. Asbestos emissions can occur during asbestos addition to the mixture, during mixing operations, and at the wad presses. The emission points are vented to the outside air through particulate collection devices.

The quantity of asbestos used in the manufacture of shotgun shells as a category is about 0.06 percent of the total asbestos consumption in the United States, a low usage level for a major source category. However, the annual asbestos consumption for the shotgun shell plant visited is approximately 454 metric tons (ca. 500 tons). The usage of this amount of asbestos at one location is large compared to that of many individual plants that are regulated by the asbestos standard.

The raw material handling and wad pressing operations potentially generate asbestos emissions comparable to those from manufacturing operations presently covered by the asbestos standard. Because asbestos emissions at shotgun shell plants are directly proportional to the asbestos usage rate, and because the plant uses relatively large quantities of asbestos, the Administrator has determined that the manufacture of shotgun shells is a major source of asbestos emissions and is therefore proposing to cover it under the asbestos standard.

The gas streams that ventilate the material-handling systems and presses present no unique problems in employing commercially available particulate control devices. The promulgated standard for asbestos manufacturing operations allows no visible emissions of asbestos-containing particulate matter to the outside air from the facility or, as an alternative, the use of specified fabric filtration devices or other control devices of equivalent effectiveness. The proposed amendment would make this provision applicable to shotgun shell plants.

Asphalt Concrete Plants

In developing the proposed standard for asphalt concrete plants, Agency personnel visited several asphalt concrete plants and had discussions with the National Asphalt Paving Association (NAPA), the AIA, asphalt plant operators, and distributors of commercial asbestos.

Asbestos is added to asphalt to give it greater strength and longer wear life. The asbestos-asphalt mixture is usually applied as a thin topping layer and is most commonly used on airport roadways, bridges, or street curbing. Only about 50 of the estimated 5000 asphalt concrete plants in the United States use asbestos each year, and the total amount of asbestos consumed by an individual plant will vary greatly from year to year. For example, in 1971, 1972, and 1973 one asphalt plant that was visited by Agency personnel produced 2300 metric tons (ca. 2500 tons), none, and 410 metric tons (ca. 450 tons), respectively, of 3 percent to 4 percent asbestos-asphalt concrete mix.

Some 4100 metric tons (ca. 4500 tons) of asbestos per year are used in the manufacture of asphalt concrete. On an annual average this amounts to 80 to 90 metric tons (ca. 90 to 100 tons) of asbestos per asphalt concrete plant that manufactures asbestos-asphalt concrete mix. The plants generally use the asbestos within a short period of time, usually less than one week. Although the annual amount of asbestos used by the individual plants is not unusually high, the rate at which individual plants use the asbestos is very high. Ninety tons of asbestos when used in one week yield an equivalent usage rate of 4500 metric tons (ca. 5000 tons) of asbestos per year. In such a situation it is possible to have high concentrations of asbestos in the vicinity of the plant during the period of usage.

The asbestos emissions of most concern are associated with the asbestos handling and mixing operations that occur during the manufacture of asphalt concrete. The asbestos fibers are bound into the asphalt concrete product, and the asbestos emissions that occur during the handling and use of the asphalt-concrete product are not considered to be major sources of asbestos emissions.

In the manufacturing process, asbestos is mixed with dried aggregate. After a short dry mixing time, hot liquid asphalt is added to the asbestos-containing aggregate and thoroughly mixed. Asbestos emissions to the outside air can occur during the addition of asbestos to the mixing device and from ventilation gases during the mixing operation. Asbestos is added to the mixing device during the dry aggregate mixing stage by use of an enclosed conveyor or, more commonly, by dumping asbestos directly into the mixer in unopened plastic bags. When asbestos is added to the mixer by an enclosed conveyor, asbestos emissions can occur during the emptying of asbestos into the conveyor hopper and from the ventilation of the mixer. The asbestos emissions during the bag-emptying operation can be controlled by hooding and ventilation of the asbestos-addition hopper. In the other, more commonly used asbestos addition method, the plastic bag is ruptured by the mixer and its contents thoroughly mixed with the aggregate. The empty plastic bags melt and become part of the product when the hot asphalt is subsequently added to the asbestos-aggregate mix. If the mixer is properly ventilated and under negative pressure, no asbestos emissions should result at the point of addition of the asbestos bags; however, the mixer ventilation gas stream is an asbestos emission point.

The raw material handling and the mixing operations potentially generate asbestos emissions comparable to those from manufacturing operations presently covered by the promulgated asbestos standard. Since the asbestos emissions at asphalt batch plants are directly proportional to the asbestos usage rate, and because some plants use relatively large quantities of asbestos for certain periods of time, the Administrator has determined that the manufacture of asphalt concrete is a major source of asbestos emissions and is therefore proposing to cover it under the asbestos standard.

The gas streams that ventilate the mixing operation and product-handling operation present no unique problem in employing commercially available particulate control devices. The asbestos emissions from the ventilation gas stream of the asbestos-addition hoppers and the mixer ventilation gas streams can be effectively controlled with commercially available technology.

The standard for asbestos manufacturing operations allows no visible emissions of asbestos-containing particulate matter to the outside air from the facility or, as an alternative, the use of specified fabric filtration devices or other control devices of equivalent effectiveness. The proposed amendment would make this provision applicable to asphalt concrete plants.

3. ASBESTOS: DEMOLITION AND RENOVATION

SUMMARY OF PROPOSED AMENDMENTS

The proposed standard applies to two types of operations:

(1) The demolition of any institutional, commercial, or industrial building (including apartment buildings having more than four dwelling units), structure, facility, installation, or portion thereof which contains any pipe, boiler, tank, reactor, turbine, furnace, or structural member that is insulated or fireproofed with friable asbestos material.

(2) The renovation of any institutional, commercial, or industrial building, structure, facility, installation, or portion thereof involving the removing or stripping of friable asbestos materials used to insulate more than 80 meters (ca. 260 feet) of pipe, or the removing or stripping of more than 15 square meters (ca. 160 square feet) of friable asbestos material used to insulate or fireproof any boiler, tank, reactor, turbine, furnace, or structural member.

The owners or operators of these operations must comply with the following requirements:

(1) Intention to demolish or renovate and specified details of the operation must be declared to the Administrator in a written notice postmarked at least 10 days prior to commencement of demolition, or as early as possible prior to commencement of either emergency demolition or renovation.

(2) Prior to wrecking, all friable asbestos materials except those encased in concrete or similar material must be removed, either by dismantling in units or sections any apparatus that is insulated or fireproofed with friable asbestos materials or by stripping the asbestos materials from the apparatus. Handling procedures for removal are specified.

(3) Throughout the removal and handling operations, all asbestos materials must be wetted except that:

  (a) Specified air cleaning methods (see Appendix A) may be used as an alternative to wetting for stripping apparatus that has been removed in units or sections.

  (b) Wetting requirements are suspended in certain instances when the temperature at the point of stripping is below 0°C (32°F).

(4) The demolition of buildings that have been determined to be structurally unsound and in danger of imminent collapse is exempt from certain requirements, including the removal of friable asbestos materials prior to wrecking.

RATIONALE FOR THE PROPOSED AMENDMENTS

After promulgation of the asbestos demolition standard on April 6, 1973, several questions and comments from demolition contractors were brought to the attention of the Agency concerning identification of friable asbestos materials, reporting procedures, and work practices acceptable under the standard. In response, certain clarifying changes which did not alter the intent or stringency of the standard were promulgated on May 3, 1974 (39 FR 15396). In addition, the Agency investigated those questions which involved possible changes in the intent of the regulation. Demolition operations involving a variety of sizes and types of buildings were visited, samples of friable and non-friable asbestos materials were taken, and demolition practices were observed. Additional information was obtained through discussions with demolition trade association personnel, demolition contractors, and local and State air pollution control personnel (see Appendix D).

The investigation indicated that amendments to the asbestos standard were necessary to more clearly define the intent of applicability of the standard, to extend the coverage of the standard, and, for some operations, to make the standard less burdensome to demolition contractors without decreasing the protection afforded. Therefore, amendments to the standard are being proposed to extend coverage to renovation operations and the stripping and removal of certain items in addition to pipes, boilers, and load-supporting structural members; to suspend certain wetting requirements under freezing weather conditions; and to clarify the types of materials and operations intended to be covered by the standard.

Addition of Renovation Operations

The asbestos standard applies to demolition operations that involve the wrecking of load-supporting structural members. Certain major renovation operations, where load-supporting structural members are not wrecked but where significant quantities of friable asbestos materials are removed, will potentially result in asbestos emissions of a magnitude similar to that from demolition. The Administrator has determined that a four-unit apartment building, the maximum size apartment building that is excluded from the asbestos demolition standard, could contain up to 80 meters of insulated pipe and 15 square meters of insulation on a boiler. Renovation operations involving the removal or stripping of quantities of friable asbestos in excess of this amount would create asbestos emissions of the same magnitude as the demolition operations presently covered by the standard. Therefore, the Administrator is proposing to extend the asbestos standard to cover renovation operations of the scale previously described.

Rather than requiring 10 days' notice of intention to renovate as in demolition operations, the Agency has specified that notice of any renovation operation must be provided as early as possible prior to the commencement of the operation. In some renovations, such as the replacement of a boiler in an apartment building, it may be infeasible to delay taking corrective action in order to provide 10 days' notice. Since the amount of notice which is feasible will vary from case to case, the Agency has made this requirement flexible.

Revisions in Demolition Procedures

The definition of "demolition," which was promulgated May 3, 1974 (39 FR 15396), potentially allows circumvention of the intended applicability of the asbestos standard. Under the original wording, removal of friable asbestos materials is not strictly considered "demolition" if it is accomplished prior to "the wrecking or removal of any load-supporting structural member." The intent of the standard is to control emissions from the stripping and removal of the friable asbestos materials as well as from the actual wrecking operations. Consequently, a revision to the definition of "demolition" is being proposed to clarify that demolition involves the removal of friable asbestos materials or specified items insulated or fireproofed with friable asbestos materials as well as the wrecking and removal of load-supporting structural members.

Under the asbestos standard, only demolition involving boilers, pipes, and load-supporting structural members insulated or fireproofed with friable asbestos materials is required to be controlled. However, enforcement of the standard has revealed that the stripping or removal in units or sections of tanks, reactors, turbines, furnaces, and non-load-supporting structural members covered with friable asbestos materials can generate asbestos emissions of a similar magnitude. The Administrator has therefore determined that the asbestos demolition standard should be expanded to regulate the stripping or removal in sections of these specified items as well, since these operations also constitute significant sources of asbestos emissions.

In addition, the asbestos demolition standard is being extended to regulate the stripping of friable asbestos materials from units or sections of pipes, boilers, tanks, reactors, turbines, furnaces, and structural members after their removal from a facility that will be demolished. Significant asbestos emissions can occur from such operations, and the Administrator is proposing that these operations should also be regulated by the asbestos demolition standard.

Demolition contractors have commented that the requirement for all friable asbestos materials to be removed from a building or structure prior to beginning demolition is not necessary in certain types of sectionalized structures which are independently supported, and that this requirement is unnecessarily burdensome. The Agency visited demolition sites where buildings and structures were being demolished in sections and observed that friable asbestos insulation in one independently supported section was not disturbed by demolition procedures in the adjoining sections. The stringency of the standard will not be altered by allowing this practice under appropriate conditions. The Administrator is therefore proposing that the demolition standard be amended to allow a load-supporting structural member to be wrecked before all friable asbestos material is removed from a building or structure, provided that: (a) the friable asbestos material in the area that is being actively wrecked is first removed according to the procedures required by the standard, and (b) the friable asbestos material in areas not being wrecked is not broken up and can still be stripped or removed prior to active wrecking in those areas.

Definition of "Friable Asbestos Materials"

The asbestos standard specifies work practices for the handling of asbestos materials during demolition operations only if those materials are "friable." The use of the word "friable" is intended to distinguish between such materials as vinyl-asbestos floor tile, in which the asbestos fibers are well bound, and such materials as the common types of molded asbestos pipe insulation, from which the asbestos fibers can be readily released. The intent of the asbestos standard is not to control handling of vinyl-asbestos floor tile, asbestos felt roofing, or other similar materials, since it is the Administrator's judgment that such activities will not release asbestos in a manner which is dangerous to human health. However, the standard does not specify a method for determining if a particular asbestos-containing material is "friable." Therefore, in order to make the intent of the standard more explicit, the Agency is proposing to define "friable asbestos materials" as "any materials that contain more than 1 percent asbestos by weight and that can be crumbled, pulverized, or reduced to powder, when dry, by hand pressure."

"Friable asbestos materials" is defined to exclude those materials that contain less than 1 percent asbestos by weight. The exclusion is intended to be consistent with section 61.22(e) of the asbestos standard which permits the use of spray-on asbestos insulation or fireproofing that contains less than 1 percent asbestos by weight. In the past, asbestos insulation or fireproofing materials have generally contained between 10 and 90 percent asbestos by weight. No known materials now contain less than 1 percent asbestos by weight except spray-on insulation or fireproofing products and materials that contain asbestos as a natural contaminant.

It is the Agency's proposed intent that such spray-on materials not be subject to the stripping and removal provisions of the demolition standard.

The Agency has received several comments from demolition trade associations and air pollution control personnel concerning the friability of corrugated asbestos paper insulation. The determination of whether this type of insulation is friable is complicated, because in some cases it is not friable and in other cases it seems to be. Friability of such paper seems to depend on the degree of deterioration of the paper binders. New paper insulation does not seem to be friable; however, if the insulation has been installed for a long period of time and subjected to a series of wetting and drying cycles, it is more likely that the binders will deteriorate and that the material will become friable. Therefore, the determination of whether corrugated asbestos paper insulation is friable or not will be made on a case-by-case basis. If demolition contractors have questions concerning whether a particular asbestos paper insulation product is friable, they should request assistance from the Enforcement Division of the appropriate EPA Regional Office.

Suspension of Certain Wetting Requirements in Sub-Freezing Temperatures

The asbestos standard contains no exemption from the wetting requirements during cold weather conditions. Demolition contractors commented that wetting at temperatures below 0°C produces freezing of oversprayed water and hazardous footing for workers.

On the basis of observations of demolition sites during freezing weather, the Administrator has determined that the spraying of water in those areas where workers will be walking presents a serious hazard. The Agency is proposing a narrow exemption from the wetting requirements during freezing weather in an attempt to balance the hazards of workmen slipping on ice and of increased asbestos emissions due to stripping inside of a building without wetting. It should be noted that only the wetting requirements are suspended in freezing weather; friable asbestos materials must still be removed from buildings prior to wrecking.

Procedures are specified in the proposed amendments which will minimize asbestos emissions when the wetting requirements are suspended because of freezing weather. Friable asbestos materials must be removed in sections whenever possible prior to the commencement of actual wrecking. Once these sections are removed from buildings, subsequent stripping of friable asbestos materials is not exempt from the wetting requirements, regardless of outside temperature. Additionally, friable asbestos material wastes must be wetted under all circumstances. The Administrator has judged that, when the above measures are taken, the suspension of wetting requirements during freezing weather will continue to protect human health with an ample margin of safety.

Methods other than wetting with water, such as the use of anti-freeze compounds, portable evacuation hoods and associated air filtering equipment, and the suspension of demolition operations in freezing weather were determined to be infeasible. The increment of additional emission control to be gained by each of the above alternatives is outweighed by practical difficulties.

Emergency Reporting Requirements

An amendment to the asbestos standard is being proposed which makes the reporting requirements for emergency demolition operations more explicit. Only buildings, structures, facilities, and installations which have been ordered to be demolished by an authorized representative of the State or local governmental agency responsible for building demolition would be exempted from the requirement of removing asbestos materials before demolition. However, the proposed amendment requires that the portions of the structure containing friable asbestos material must be wetted during the wrecking operation. This requirement applies even in freezing weather, since the spraying operation will not endanger workmen within the building. As specified in the asbestos standard, it is also necessary that the building, structure, facility, or installation be structurally unsound and in danger of imminent collapse. Agency personnel contacted State and local governmental agencies responsible for building demolition to determine the approximate annual number of emergency demolition operations. No specific number was obtained, but estimates from State and local governmental agencies indicated that emergency demolition operations do not occur frequently.

Under the proposed amendment, the report of intention to demolish submitted by the owner or operator of the demolition operation must include the name, title, and authority of the person who orders the demolition to be carried out. The proposed amendment requires such reports to be postmarked as early as possible prior to the commencement of demolition.

4. ASBESTOS: FABRICATION

SUMMARY OF PROPOSED AMENDMENTS

There shall be no visible emissions to the outside air from the following operations:

(1) The fabrication of friction products, excluding those operations that primarily install asbestos friction materials on motor vehicles.

(2) The fabrication of asbestos-cement building products.

(3) The fabrication of asbestos-cement or asbestos-silicate board for ventilation hoods; ovens; electrical panels; laboratory furniture; bulkheads, partitions, and ceilings for marine construction; and flow control devices for the molten metal industry.

As an alternative to the no-visible-emission standard, specified air-cleaning methods may be used (see Appendix A).

Molded insulating materials that are friable and wet-applied insulating materials that are friable after drying, installed after the effective date of the standard, shall contain no commercial asbestos. Spray-applied insulating materials are excluded.

RATIONALE FOR THE PROPOSED AMENDMENTS

Asbestos is used in numerous products because of its multi-beneficial properties. For example, one company advertises that there are over 3200 end uses for asbestos. Although the number of specific uses is large, the major uses of asbestos can be categorized into the following groupings:

Table 4-1. ASBESTOS CONSUMPTION BY MAJOR PRODUCT CATEGORIES

Asbestos End Use	1972 Consumption[1] (Metric Tons)	(Ca. Short Tons)	Percent
Floor Tile	80,800	89,000	11
Friction Products	73,600	81,000	10
Felt and Paper	109,900	121,000	15
Packing and Gaskets	29,000	32,000	4
Textiles	7,300	8,000	1
Sprayed Insulation	14,500	16,000	2
Construction Industry	308,700	340,000	42
Miscellaneous	109,900	121,000	15

This listing is based on the most recent Bureau of Mines reporting format. It differs significantly from the method previously used to present such data because it is based on an expanded list of consumers. A further breakdown of the 42 percent used in the construction industry is:

Asbestos-Cement Pipe	19%[2]
Asbestos-Cement Building Products	7%
Floor Tile used in Construction	8%
Miscellaneous	8%

Many of these products are fabricated, either at the manufacturing location or at a separate location, prior to application in an end use.

Some fabrication involves cutting or shearing operations which do not generate large quantities of asbestos emissions, for example, the cutting to size of vinyl-asbestos floor tile during installation. In other instances, processing which could be performed at fabrication sites is incorporated into manufacturing operations; emissions from this type of processing are already covered by the asbestos standard. However, some fabrication operations, such as the grinding of motor vehicle brake linings, can be carried out either at the site of manufacture or at a different central fabricating site. Fabrication at a different site is not covered by the asbestos standard.

The petition of the Environmental Defense Fund questioned the exclusion of fabrication operations from the asbestos standard. As a result of these questions, the Agency visited 15 plants that perform fabricating operations on manufactured asbestos products and consulted with several plant operators and trade associations (see Appendix D). From this investigation, it was concluded that asbestos products other than friable insulating products are field-fabricated to only a limited extent, but that the fabrication of certain categories of asbestos products in central shops is a major source of asbestos emissions. The investigation was thus divided into the two main areas of field fabrication and central shop fabrication.

The proposed asbestos standard for fabrication includes all known major fabrication categories. The major fabrication categories were determined by the Agency to be the fabrication of friction products, the fabrication of asbestos-cement products, and the fabrication of asbestos-cement or -silicate boards for several end uses. These categories account for approximately 40 percent (see Table 4-1) of the asbestos consumed in the U. S. The asbestos product categories of floor tile, felt and paper, packing and gaskets, textiles, and sprayed insulation account for approximately 35 percent of the U. S. asbestos consumption, but do not generate significant amounts of asbestos emissions.

Field Fabrication

The investigation revealed that installation of friable asbestos insulation materials for pipe, boilers, tanks, reactors, turbines, and furnaces is the only known major source of asbestos emissions from field fabrication. The task of installing and removing asbestos insulating materials is a known source of occupational asbestos exposure.[3,4,5] Asbestos products have been used extensively for thermal insulation of pipes, boilers, tanks, reactors, and furnaces. The products are used in residential, commercial, and industrial buildings, as well as on ships. The asbestos functions as a reinforcing agent in molded semicircular sections, sheets, and blocks of such materials as magnesium carbonate and calcium silicate.

Molded asbestos insulation is field-fabricated by cutting and sawing the insulating material at the site of installation to fit contours of specific equipment. This type of field fabrication was common practice in the past, frequently at new construction sites for buildings and industrial plants. Powdered material of similar composition is mixed with water into a slurry and applied by hand trowel to fill the crevices between molded sections and to insulate irregular shapes. Most of the molded asbestos insulating products are friable and can create, along with wet-applied insulation, significant amounts of dust during field-fabrication operations. Some control methods exist for installation, but these methods still permit asbestos emissions.

The use of molded asbestos insulation is currently being phased out.[6,7] Asbestos-free insulating products have been developed for a number of applications largely because of the known occupational hazards of installing products such as the common types of molded asbestos pipe insulation. These substitutes are available for the complete range of temperature requirements. Fiberglass is used at lower temperatures and refractory fiber insulations can be used for extremely high temperature requirements.[8]

Because an economical and effective control method (i.e., the adoption of asbestos-free insulating products) is available, the Administrator has determined that, in order to protect public health with an ample margin of safety, it would be prudent to prohibit the use of friable asbestos insulating products and is proposing to do so. Even though the use of these asbestos products in the U. S. has been largely discontinued, a regulation is necessary to stop the use where it is being practiced and to prevent the possible future use of friable asbestos insulating products.

Asbestos products other than insulating products are field-fabricated to only a limited extent. Asbestos-cement pipes, asbestos-cement building products, and asbestos board products were found to be fabricated almost completely in central shops. The only required field fabrication of such products is drilling holes and cutting pieces to fit in a limited number of cases. The Agency found that the asbestos-cement products that were field-fabricated were usually cut with knives or saws equipped with dust-collection devices, and holes were drilled with drills equipped with dust-collection devices. Accordingly, the Agency has determined that the field fabrication of asbestos products other than insulating products is not a major source of asbestos emissions to the air.

Central Shop Fabrication

Friction Products -- Enforcement of the asbestos standard revealed the existence of facilities that fabricate large quantities of automotive brake shoe linings, but do not manufacture the linings. These fabrication sources are not covered by the standard because the Agency was not aware of them at the time of promulgation. The fabricating operations performed at these facilities are similar to those performed at asbestos friction product manufacturing plants, which are covered as major sources of asbestos emissions by the asbestos standard. The amount of dust generated from grinding, drilling, sanding, and cutting operations is about 450 grams (ca. 1 pound) for every 30 brake shoes fabricated. For a large facility that fabricates over 2 million brake shoes per year, this amounts to over 27 metric tons (ca. 30 tons) of asbestos dust per year. Because the operations are also similar in quantity of asbestos emissions generated, the Agency is proposing that the asbestos standard be amended to include these fabrication operations.

Agency representatives also visited several individual brake shoe installers to inspect the facilities and operations. The installers radius-grind wheel drums as well as brake shoes to ensure good braking immediately after installation. Relatively small quantities of asbestos-containing dust are generated by the individual installers, and even these small quantities were well controlled by fabric filters at the facilities inspected. The combination brake drum grinding and brake shoe radius-grinding machines are equipped with a local dust pickup and a small integral fabric filter for collection of the brake dust. On the basis of these inspections, the Administrator has concluded that these operations do not cause an atmospheric emission problem, and therefore these operations are not included in the proposed fabrication standard.

Building Products -- Asbestos is used in numerous cement building products. The most common asbestos-cement building products include flat sheets, corrugated sheets, shingles, and panels which are used for walls and roofs of industrial buildings, canal bulkheads, cooling tower construction, and other applications. Agency personnel visited three distributors of asbestos building products that performed fabricating operations in a central shop. The major fabrication operations at these facilities involved sawing, trimming, drilling, and grinding of asbestos-cement building products to meet customer specifications. Cooling tower manufacturers that were contacted have all sheets cut and drilled for each cooling tower by the asbestos sheet manufacturer or distributor at a central fabricating shop. Fabrication in the field is done only occasionally when a pre-cut and pre-drilled sheet will not fit.[9,10] The flat asbestos sheets as used in homes, barns, or other inexpensive construction are usually installed with fasteners or nails and require little drilling. Similarly, asbestos shingles are delivered to the job site with pre-punched holes and are nailed to the house. Additional holes are punched out in the field with an anvil puncher, and the siding shingles are cut using a guillotine cutter and knife. Little, if any, field fabrication occurs which could cause asbestos emissions.

Fabrication of asbestos-cement pipe by the manufacturers involves machining ends and cutting pipe to exact dimensions which provides for easy assembly and a water-tight fit. Therefore, fabrication of asbestos-cement pipe rarely occurs after the pipe leaves the manufacturing location. The only field fabrication is an occasional cutting or tapping of a pipe. The amount of asbestos-containing dust generated by central shops that fabricate asbestos-cement building products was estimated to be approximately 90 kg/week (ca. 200 lb/week). The Administrator has judged that uncontrolled asbestos emissions from such fabrication shops are comparable to uncontrolled asbestos emissions from asbestos manufacturing sources presently covered by the standard, and therefore is proposing standards to limit asbestos emissions from these sources.

Specialty Products--Asbestos-cement and asbestos-silicate boards are used in construction of ovens, electrical panels, laboratory furniture, ship bulkheads, and flow control devices for the molten metal industry. For example, the molten metal industry requires 1,200,000 board feet of heat-treated asbestos boards per year. The number of plants using these boards is large and includes most of the primary aluminum plants as well as many other molten metal handling operations. The largest of these facilities do their own fabricating work, though many have it fabricated by distributors or small machine shops. Data from an aluminum plant that was visited showed that the dust generated during machining of flow control devices for the molten metal industry could amount to 1/3 of the board weight prior to machining.

Asbestos board products are also used for bulkheads and ceilings in commercial vessels and as partition walls in the living quarters of offshore oil derricks. Approximately 64 metric tons (ca. 70 tons) were installed on one transport ship which was inspected by Agency personnel. According to discussions with asbestos product manufacturers, there are probably fewer than 10 distributors of asbestos board to the marine industry, and fabrication performed by the distributors generally involves cutting 4- by 8-ft sheets to specified lengths on table saws. The Administrator has judged that uncontrolled asbestos emissions from the fabrication of asbestos-cement and silicate boards for ventilation hoods, ovens, electrical panels, laboratory furniture, marine construction, and flow control devices for the molten metal industry are comparable to uncontrolled asbestos emissions from asbestos manufacturing sources presently covered by the asbestos standard and therefore is proposing an amendment to limit asbestos emissions from these sources.

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5. DISPOSAL OF ASBESTOS WASTES

SUMMARY OF PROPOSED AMENDMENTS

Disposal of Wastes from Manufacturing, Fabricating, Demolition, Renovation, and Spraying Operations

There shall be no visible emissions to the outside air from any stage of waste handling, extending from collection through deposition, of:

(1) Asbestos-containing waste generated by manufacturing and fabricating operations, and by the sprayed application of asbestos insulating or fireproofing materials, and

(2) Friable asbestos waste and control device asbestos waste generated by demolition and renovation operations.

Alternatives to the no-visible-emission standard include:

(1) Specified wetting, packaging, and labeling procedures.

(2) Pelletizing of wastes into non-friable pellets prior to disposal. Either the collecting and the pelletizing of the wastes shall generate no visible emissions to the outside air, or specified air cleaning methods (see Appendix A) shall be used for these operations.

(3) Other disposal methods approved by the Administrator.

Incineration of containers that previously contained commercial asbestos is prohibited.

Disposal of Wastes from Asbestos Mills

There shall be no visible emission to the outside air from any stage of waste handling, extending from collection through deposition, of asbestos ore tailings or control device asbestos waste generated by an asbestos mill.

As an alternative to the no-visible-emission standard, the wastes may be transferred to the tailings conveyor in a manner that generates no visible emissions to the outside air and may then be wetted with a dust-suppression agent in a manner that generates no visible emissions. Control device asbestos waste may also be handled according to the alternative procedures specified for wastes generated by manufacturing, fabricating, demolition, renovation, and spraying operations (see previous section).

Waste Disposal Sites

There shall be no visible emissions to the outside air from either active or inactive waste disposal sites where asbestos-containing waste has been deposited.

Warning signs shall be posted at all entrances to active or inactive waste disposal sites and at least every 100 meters (ca. 330 feet) along property lines. Legend and format of the signs are specified in the regulation.

Asbestos-containing sections of waste disposal sites shall be fenced to deter public access unless specified requirements for covering the area with non-asbestos-containing materials are met.

Alternatives to the no-visible-emission standard are divided according to the type of site:

(1) Active sections -- Application of a dust-suppression agent or a 15-centimeter (ca. 6-inch) layer of non-asbestos-containin material at the end of each operating day or once every 24 hour when the site is in continuous operation.

(2) Inactive sections of disposal sites other than asbestos mill tailings disposal sites -- Application of a 15-centimeter (ca. 6-inch) layer of compacted non-asbestos-containing material on which a vegetation cover adequate to control wind and water erosion is maintained, or application of a 60-centimeter (ca. 2-foot) layer of compacted non-asbestos-containing material maintained to prevent exposure of the asbestos waste from erosion.

(3) Inactive sections of asbestos mill tailings disposal sites -- Application of dust-suppression agents sufficient to control wind erosion, or either of the two methods specified for inactive sections of disposal sites other than asbestos mill tailings disposal sites (see previous item).

RATIONALE FOR PROPOSED AMENDMENTS

The petition of the Environmental Defense Fund, et al., questioned the exclusion of asbestos waste disposal operations, including some portions of asbestos mill tailings disposal operations, from the standard. In response to the questions raised, the Agency initiated a further study of emissions from the disposal of asbestos-containing waste materials. During the course of this investigation, which covered the waste disposal process from the point of waste generation to the ultimate disposal site, waste disposal practices were observed at six asbestos mill tailings disposal operations, twenty-three fabrication and manufacturing plants, one demolition waste disposal operation, and six ultimate waste disposal operations.

From observations at various facilities of the quantity of waste handled, dustiness of the waste, and types of handling operations necessary to dispose of the waste, it was concluded that major asbestos emissions could occur at any point during the disposal operations from the collection of asbestos-containing waste to the depositing of the waste at a disposal area. The improper operation of a disposal site where asbestos-containing waste is deposited can also result in emissions from both active and inactive portions of the site. The Agency's investigation included ambient air studies in the vicinity of a large asbestos mill tailings disposal site and a large manufacturing and fabrication asbestos waste disposal site. The investigation concluded that: (1) the disposal of asbestos waste generated by asbestos manufacturing, fabrication, spraying, renovation, and demolition operations is a major source of asbestos emissions and that emissions from all stages of waste disposal, from collection to deposition at a disposal site, from these operations should be regulated; (2) the disposal of tailings and other wastes from asbestos mills is a major asbestos emission source and that emissions from all stages of waste disposal, from collection to deposition at a disposal site, should be regulated; and (3) the asbestos emissions from asbestos waste disposal sites are a major asbestos emission source and should be controlled.

Process Wastes

Asbestos Manufacturing Waste -- The manufacture of numerous asbestos-cement board products involves mixing asbestos with cement, water and other additives; the mixture is subsequently allowed to dry or cure.

Some of the products must be finished by grinding, sawing, and polishing while others are ready for shipment without any fabrication. Examples of products include high-density monolithic (stonelike) board, asbestos board for marine applications, heat-treated asbestos boards for marine applications, heat-treated asbestos boards for the molten metal industry, corrugated asbestos siding, and blackboards.

Four basic types of asbestos wastes were observed which can exist at almost all asbestos-cement board plants: process slurry wastes, asbestos dust collected in baghouses, scrap product, and empty bags which previously contained asbestos. Amounts of each type of waste depend on the product being made and the finishing required. For example, a large plant that produces 3 million board feed of product per year generates each day approximately 8 cubic meters (ca. 10 cubic yards) of dust, 9 cubic meters (ca. 12 cubic yards) of scrap board, and 9 cubic meters (ca. 12 cubic yards) of empty paper bags that previously contained asbestos.

Fourteen pipe plants in the U.S. manufacture for various uses asbestos pipe that ranges from 7.6 to 122 cm (ca. 3 to 48 inches) in diameter. Differences were observed in the waste disposal practices at the plants that were visited during the investigation, but the techniques that were observed are representative of those used at other asbestos-cement pipe plants.

Substantial amounts of dust and other waste are created in the manufacturing of asbestos-cement pipe. The types of waste generated at pipe plants include dust from various cutting and machining operations, scrap and broken pipe, slurries, and solid waste that includes asbestos shipping bags (both plastic and paper). The slurry is a waste product from the process and contains residual constituents that do not bind into the pipe. As an example of the quantity of waste generated, a pipe plant in California generates 6 cubic meters of dust, 14 cubic meters of paper bags and pipe, and 450 kg (ca. 1000 pounds) of slurry process waste each day.

In the production of friction products, asbestos emissions are controlled from the handling of asbestos in bags and operations (such as weighing of raw materials, charging of mixers, blending of component ingredients, and discharging of mixers) that involve asbestos in dry-mixed molding compounds. However, fabricating operations on the products can generate much greater quantities of asbestos-containing dust from the use of band saws, abrasive wheels, drills, cylindrical grinders, and circular saws. The grinding and drilling of brake linings during manufacture release as much as 30 percent of the lining material as waste. In most cases these emissions are significant and are collected in baghouses. Discussions with plant operators indicated that 12,200 to 45,400 kg (ca. 27,000 to 100,000 pounds) per month can be generated by large brake shoe manufacturing facilities. The only other asbestos wastes are rejected products and paper or plastic bags which contained asbestos.

Wastes from the manufacture of asbestos paper consist of asbestos sludge from the waste water and scrap pieces of asbestos paper from edge trimmings and defective rolls. The asbestos fibers are held together with such binders as starch, glue, water glass, resins, latex, cement, and gypsum. Most of the scrap waste and sludge can be recycled except when binders like rubber are used.

The paper bags containing the asbestos are pulpable and become part of the final product. The cohesive nature of the sludges waiting to be recycled and the entrapped asbestos fibers in scrap paper reduce any potential airborne emission problems.

Asbestos textile mills consume 1 to 3 percent of the asbestos used in the U.S. in the production of roving, carded lap, yarn, cord, rope, square-plaited goods, braided tubing, tape, webbing, and cloth. Based on an inspection of a small spinning operation, wastes consist of dry dusty asbestos, wet slurry waste, and rejected pieces of yarn. Amounts of waste vary depending on the size of the operation and the types of products. The small yarn spinning operation which was inspected disposed of 9 kg (ca. 20 pounds) of waste per day.

All manufacturing operations producing asbestos-containing products have the potential to create waste disposal problems. The emission potential associated with the wastes differs depending on binding agents and dustiness of the waste. For example, cement building products, in which the asbestos fibers are tightly bound, will pose lesser air pollution problems during disposal. Most plants mix asbestos waste such as shipping bags with non-asbestos waste, and the local waste collector, either public or private, picks up the mixture and usually dumps it in a landfill area. These asbestos-containing waste materials are usually disposed of without regard to their potential as emission sources.

Asbestos Fabrication Waste -- The basic fabrication operations of sawing, shearing, grinding, milling, and drilling of manufactured asbestos products generate asbestos dust which is vented to and is collected by control devices. The asbestos-containing waste generated from such operations includes control device waste as well as scrap products from the fabrication operations.

Asbestos Demolition and Renovation Waste -- The waste generated by demolition and renovation operations is friable asbestos material waste, vacuum cleaner dust, and units insulated or fireproofed with friable asbestos material. The asbestos waste can be removed from units or sections in pieces or left intact on pipes, boilers, and other items, and the whole unit disposed of in a section. The waste generated from renovation operations is similar in nature to demolition waste.

Asbestos Spraying Waste -- Asbestos-containing waste from the spray application of asbestos fireproofing and insulating products consists mainly of oversprayed products. Approximately 10 percent of the material that is sprayed ends as waste material and has to be disposed of. This material is usually collected by sweeping and scraping after a spray application and usually is disposed of in a slightly wet form.

Asbestos Mill Waste -- Mill waste consists of the ore tailings, which vary in size from dust to 1/2 inch diameter, and control device asbestos waste (baghouse dust). All mills except one produce dry tailings. The exception uses a wet asbestos-extraction technique and produces wet tailings.

Waste Disposal Practices

Disposal of Manufacturing Wastes -- Asbestos waste materials generated at manufacturing plants consist of process waste, control equipment waste, scrap product waste, and emptied asbestos shipping bags. Amounts and types of wastes that must be disposed of vary with the product, production rate, and amount of waste that can be recycled. Disposal practices vary somewhat among plants, but the basic procedures are similar.

Collected baghouse dust and other dusty waste are disposed of by (1) transferring the dust from the baghouse hopper to a truck or trash dumpster, (2) transporting the dust to a disposal site, and (3) depositing the dust in a landfill. Screw conveyor systems are usually used to remove dust from baghouses, but an emission-producing method of dumping the dust directly into a truck is also used. At another plant, 6 cubic meters of dust per day is placed in a truck and wetted down prior to being driven to a county landfill operation. Although visible emissions generally should not occur while the dust is in the dump truck, visible emissions occur while the dust is being dumped and buried. Baghouse dust that cannot be recycled at one plant is put into a dumpster and transported to a company-owned waste pile. The handling of this dust is a potential source of emissions. At one large plant, 11 cubic meters (ca. 15 cubic yards) per day is transported in a dumpster to a slurry pond where the dust is emptied and later mixed with water and slurry waste from the rest of the plant. An emission problem does exist in this operation before the dust has been wetted.

One method used to dispose of baghouse dust from machining operations is to transport the collected dust (about 1 cubic meter per day in a dumpster with the top sprayed with water and covered with a tarp) to a pond where water is mixed with the dust to form a slurry, which is subsequently mixed with waste slurry from the manufacturing process. Emission potential is reduced during transportation, but dust near the pond shows some emissions still occur during dumping operations.

To prevent asbestos emissions during transport to a landfill, dust can be mixed with water, sprayed with water and covered, transported in a closed container, or pelletized. The only disposal techniques for baghouse dust that were observed to be emission-free during landfill operations were those using sufficiently wetted, pelletized, or slurried wastes. Where only small quantities of dust must be handled, sealed plastic bags can be used to contain asbestos fibers during disposal. Two asbestos brake shoe lining manufacturers use pelletizing units to ensure dust-free conditions during waste disposal operations. Baghouse dust from one machining operation on asbestos boards is pelletized and transported (about 8 cubic meters per day) to a landfill; this method greatly reduces air pollution potential from the waste during disposal.

Only one disposal technique used for non-friable asbestos waste was observed to produce visible emissions. At an asbestos-cement pipe manufacturing plant, scrap or reject pipe (about 900 kg per day) that is not crushed and recycled to the process is hauled by trucks to the plant-owned disposal dump. The company hires a contractor to crush the pipe with a bulldozer about every 8 weeks. Some emissions were visible during the crushing operation. The visible dust usually settled to the ground in less than 15 seconds, and only crossed the plant boundary twice during an 8-hour period.

One type of asbestos-containing waste common to almost all manufacturers is shipping bags. The handling of these bags, which contain residual amounts of asbestos fibers, presents a potential emission problem. Several plants observed by the Agency combine the bags with non-asbestos materials for disposal by trash collectors. Several plants seal the emptied bags in plastic bags before combining them in dumpsters or compactors with non-asbestos waste for disposal. One asbestos-cement plant seals the bags in plastic bags (about 9 cubic meters per day) and then buries them in the plant landfill. One manufacturing plant incinerates emptied bags contaminated with asbestos fibers, which can result in asbestos emissions. There is no known control device available that allows most solid waste incinerators to control particulate emissions to the level achievable for such sources as asbestos mills and manufacturing operations covered by the asbestos standard. There are environmentally acceptable alternative disposal methods for disposing of such waste, such as landfilling. Accordingly, the Administrator has proposed to prohibit the incineration of containers such as paper or plastic bags that previously contained commercial asbestos.

Process slurry wastes from manufacturing plants are disposed of while wet and do not appear to pose atmospheric emission problems during the disposal process. Each asbestos-cement manufacturing plant has somewhat different disposal problems that depend on location and recycle capabilities. Volumes of process waste slurry can be large; for example, at one plant about 23 cubic meters per day of the wastes are pumped into a lagoon. Smaller amounts of slurry wastes are dumped into the city sewer system at one plant; this practice potentially causes a water pollution hazard. Process slurry from an asbestos-cement pipe manufacturing plant [about 45,000 liters (ca. 12,000 gallons) per week] is transported to a section of a dump where it is allowed to dry in a settling pond. When it reaches the consistency of damp clay, the material is taken from the pond and stored in piles. This material is finally mixed in layers with crushed pipe to form a solid waste pile. One plant shovels slurry from a lagoon into piles where it is allowed to partially dry before it is transported to a county landfill (about 450 kg per day). The county dump requested that the slurry be partially dried before it is brought to the landfill to facilitate handling. Slurry from the settling pond at one plant is scooped out, placed in closed containers on trucks, and taken to the plant landfill. There appears to be no air pollution problem in transporting the slurry to the plant landfill. At the landfill, all plant waste is mixed with waste from the city and covered within 24 hours. Slurry wastes are also disposed of from textile manufacturing operations. Dried wastes from asbestos-cement products were observed to be cohesive and did not indicate significant emission potential.

One of the best methods to reduce or eliminate waste materials is to recycle them into asbestos manufacturing processes. Asbestos-cement pipe plants recycle much of their dust waste and scrap pipe. However, not all pipe can be recycled because of either economics or type of pipe produced. Attempts have been made to recycle dust from asbestos boards, but the result was a weak product. All wastes at an asbestos paper plant can be recycled except scraps of paper containing rubber-type binders. Friction product scraps are generally not recyclable because they degrade the quality of the product.

Disposal of Fabricating Wastes -- Asbestos fabrication waste materials that must be handled can be classified into three basic types: dusty wastes, slurry wastes, and material scraps. Most of the dusty and slurry wastes are those collected by emission control systems. The amount of this type of waste generated governs the waste disposal techniques which can be used. For small amounts of dust [up to about 0.3 cubic meters (ca. 10 cubic feet) per day], plastic bags can be used as airtight containers during disposal.

Several methods are used to handle relatively small amounts of dusty and slurry wastes at various plants. Waste collected in the baghouses from table saw operations is placed inside cardboard barrels and labeled with the OSHA asbestos warning notice prior to disposal. Waste collected in cloth bags from portable power tools is dumped into plastic bags, mixed with cement and water, and then added to other trash for disposal.

One central shop that sizes asbestos-cement boards prior to shipment to a job site generates about 190 liters (ca. 50 gallons) of dry dust per day from table saws. Eight liters (ca. 2 gallons) per day of dust are collected from portable drills and saws used while the boards are being installed. Waste generated from machining asbestos boards for the molten metal industry varies in consistency from fine dust (sawing and sanding operations) to chips (lathes and drills). Waste generated from machining can amount to as much as 30 percent of the board weight. About 380 liters (ca. 100 gallons) per day of asbestos slurry is removed from a rotoclone at an aluminum plant that was inspected by the Agency. This slurry is transported by a dumpster and compactor to a landfill before it has time to dry and become dusty. Baghouse waste from a large distributor of molten metal board is sealed in plastic bags and placed in trash dumpsters for transportation to a landfill. The amount of dust generated from textile cutting operations is relatively small and can be disposed of in impermeable containers.

Large quantities of dusty wastes are handled somewhat differently than small amounts. Waste collected in large baghouses at a brake shoe fabricating plant from drilling and grinding operations is transported by truck to landfills and can amount to 12,200 kg (ca. 27,000 pounds) per month for a plant producing 40,000 shoes per day. At this plant, dust from the baghouse is dumped into a special covered dump truck using canvas dust suppressors around each spout. Some visible emissions were observed around the bottom of the baghouse, which indicates that emissions can occur during the operation. Water is then added and blended with the dust, using a large mixer, before the loaded truck is washed to remove asbestos dust and driven to a landfill. Some brake shoe fabricating plants use pelletizers which, through the addition of water, convert the dusty baghouse waste into small balls that are transported to a landfill. Cement can be added to the pelletizer along with the water as an additional binding agent for the asbestos.

Scrap asbestos wastes can often be handled in the same way as non-asbestos wastes if the asbestos fibers have been bound or encapsulated so that emissions to the atmosphere are not likely to occur. This is the case for many asbestos wastes from fabrication involving cement pipe, cement boards, cement building products, friction products, floor tile, paper products (containing appropriate binders), and many gasket materials. Scrap boards from most operations inspected are placed in trash bins for disposal along with non-asbestos wastes. One fabricator places scrap boards from the cutting operations inside cardboard drums which are lined with plastic bags. These are sealed, transported to a storage area, covered with a plastic tarp, and then trucked to a landfill. Scrap materials from fabricating operations using paper consist of two types: scrap pieces of paper from cutting operations and scrap or rejected pieces of finished product. In most cases, finished product scrap has been modified by the addition of a binding or waterproofing material such as asphalt or vinyl, and this material should not pose an air pollution threat regardless of disposal techniques used. Unmodified paper scrap (excluding paper containing a rubber binder) can be recycled by the paper manufacturers.

Some types of asbestos scrap wastes are friable, and waste disposal techniques similar to those used in handling asbestos dust should be used. The installation and removal of asbestos molded pipe, sheet, and block insulation during new construction or repair from pipes, boilers, breechings, turbines, and furnaces is the largest source of friable asbestos waste materials. At one shipyard, asbestos waste is collected in plastic bags and put into hoppers for pickup and disposal by a private contractor. The amount of waste varies depending on the extent of the repair job and the size of the ship, but usually ranges between 0.7 and 4.5 metric tons (ca. 3/4 and 5 tons) per ship. Because asbestos waste is not placed in separate dumpsters from other waste, the private contractor handling the waste might not know it contains asbestos. The wastes are trucked to a private landfill.

The practice of transporting the waste to landfills along with non-asbestos waste using several types of equipment potentially presents a problem. Most of this material is handled by non-company employees who are unaware of the potential hazard in breathing asbestos fibers. Compactors, open dumpsters, bulldozers, and careless handling of the plastic bags can cause the bags to break open and create an asbestos emission problem.

Disposal of Demolition and Renovation Wastes -- The friable asbestos materials removed from demolition operations already covered under the asbestos standard are required to be wetted but no additional procedures are provided. The Agency's investigation indicates that the demolition debris is frequently deposited in landfill operations.

Disposal of Spraying Wastes -- Spraying wastes are generally collected and packaged before drying, and the containers are subsequently deposited in landfills.

Disposal of Asbestos Mill Wastes -- Waste disposal practices at asbestos mills are usually different from the disposal techniques used by asbestos manufacturing sources because the mills generate much larger quantities of waste. A large asbestos tailings disposal site may have a surface area of 400,000 m^2 (ca. 100 acres) whereas a large manufacturing and fabrication waste disposal site may have a surface area of 12,000 m^2 (ca. 3 acres). The largest mill in the United States, located in Hyde Park, Vermont, disposes of over one million metric tons of asbestos tailings annually. Smaller operations in California have to dispose of lesser amounts of tailings, but such quantities are large compared to quantities of wastes from most asbestos manufacturing sources. Asbestos mills generally dispose of wastes on a nearby area owned and operated by the mill. The asbestos mill tailings contain from less than 1 percent asbestos by weight, in the case of the Vermont mill, to in excess of 30 percent asbestos by weight in some California operations. Asbestos emissions from wind erosion can result if methods to prevent such emissions are not employed.

During its investigation, the Agency visited all six of the major asbestos mills in the United States and conducted an ambient air study at the large Vermont mill in order to determine whether the disposal of tailings at asbestos mills is a major source of asbestos emissions (see Appendix D). The Agency's investigation included inspections of active and inactive portions of tailings disposal sites, and the deposition and distribution of the waste on the disposal sites.

Mill wastes are usually conveyed from the mill on an enclosed conveyor system to a disposal pile. The conveyor system usually requires several transfer operations from one conveyor section to the next. For example, the Vermont mill conveys the mill tailings over 300 meters (ca. 1000 feet) to the tailings pile, and the tailings conveyor has 13 transfer points. Asbestos emissions from the enclosed conveyor and transfer operations are controlled by the asbestos mill standard (38 FR 8820).

A primary purpose of the investigation was to observe methods of controlling emissions during the dumping of tailings onto the disposal pile. The tailings fall 2.5 to 3 meters from the discharge conveyor to the disposal pile, and emissions from this operation are often uncontrolled. One mill disposes of dry mill tailings by dropping them onto the pile through an inverted-funnel-type device intended to control emissions. A portion of this device is ventilated to help reduce emissions during discharge of tailings through the hood, and the ventilation stream is treated in a baghouse. This type of dust control technique is evidently not very effective in reducing dust emissions since visible emissions were noted at frequent intervals in an Agency inspection. Two mills use another disposal method in which the tailings are wetted with a screw mixer before being discharged to the tailings pile. The screw mixing device is usually arranged so that the mixing occurs at a conveyor transfer point. One device consists of a screw auger approximately 1.5 meters long which turns in a trough where a spray system installed over the length of the auger wets the tailings with water and resinous or petroleum-based dust-suppression agents. No visible emissions were noted during the wet tailings disposal operation. This method of disposal also helps to reduce windblown emissions from the tailings pile because the wetted tailings after drying form a crust which reduces windblown emissions. Even walking on one tailings pile did not break the crust layer.

The wet screw method is judged to be the most effective method for controlling emissions from asbestos tailings disposal. None of the mills presently operating in the United States would have any major problems installing this system. Freezing weather may cause some operational problems, but a Canadian asbestos mill has successfully operated a wet asbestos tailings disposal system in most cold weather conditions. The wet mixing operation is performed in the mill at the bottom of the tailings conveyor and uses a screw-type mixer. The coarse tailings (plus 35 mesh) are first mixed with water in the screw mixer with sufficient water to thoroughly coat each particle. This wet mixture is deposited on the tailings conveyor belt, and finer tailings are then deposited on top of the wet mixture. This layered mixture is progressively blended with each transfer point in the tailings system. Freezing is not a major problem until temperatures become below -18°C (ca. 0°F); some freezing at conveyor transfer points then restricts the flow of tailings and causes tailings buildup in the transfer chutes. This problem might be solved by insulating and heating the transfer points and using nonmetallic chute linings. Since a wet tailings disposal system is operated routinely in freezing temperatures above -18°C (ca. 0°F), this method of tailings disposal should be generally applicable to asbestos mills in the United States. Only one mill in the United States may experience some difficulty in wetting during the winter months because of freezing weather.

Waste Disposal Sites

Control and Maintenance Practices -- Disposal sites can be classified into two types, active and inactive. An inactive site, or inactive portion of a site, is an area where waste has been deposited but where no additional waste is being added and the surface of the area remains undisturbed by waste disposal activities. All other sites, or portions of sites, are defined as active sites since waste is being added or the surface is being otherwise disturbed. The basic procedures that are currently used to control emissions are to cover the asbestos waste with soil, to grow vegetation, or to apply resinous or petroleum-based dust-suppression agents. The coverage with soil or the application of a dust-suppression agent to an active portion of a site has to be frequent enough to prevent windblown emissions from the waste deposited between periods of coverage or application. The coverage or application at the end of the operating day, or at least once in each 24-hour period, should provide effective control of such emissions.

The asbestos emissions from an inactive site can be reduced by applying soil to cover the waste and maintaining a vegetative cover, or by applying dust-suppression agents to prevent windblown emissions. When the waste is covered with soil and a cover of vegetation is planted and maintained, the vegetative cover and roots of the vegetation reduce water erosion and prevent wind erosion. Since this does not require as great a degree of care as is needed in maintenance for dust-suppression agents, it is in most cases the most desirable control method. For very large sites, however, this method is not practical. For example, an asbestos mill waste disposal site can be as large as 400,000 m^2 (ca. 100 acres) in area and have banked sides of up to 60°. Vegetation does not grow naturally on such waste because of the alkalinity of the waste, and coverage with soil is very expensive because of the large area. Moreover, obtaining sufficient soil to cover a large area could itself create land and water environmental problems. However, resinous or petroleum-based dust-suppression agents have been successfully used to control wind erosion from large sites (see Appendix B). These methods are effective with proper site preparation, application and maintenance of the agent. The surface is wetted with the agent;

after drying, the dust and waste are bound by the adhesive quality of the agent and the waste forms a crust which reduces wind and water erosion. These agents have to be reapplied at intervals ranging from 1 to 3 years to maintain their effectiveness.

The methods proposed as alternatives to compliance with the no-visible emission standard for inactive sections of disposal sites require, where practical, the use of cover. Where cover is judged to be impractical, i.e., on most asbestos tailings piles, another effective control method allowing the use of dust-suppression agents is proposed. Since dust-suppression agents must be maintained more carefully than cover and since there may be a water pollution problem associated with improper use of such agents, this control method is not specified where cover can be practically applied.

Ambient Asbestos Concentrations Near Disposal Sites -- The magnitude of emissions from asbestos waste disposal operations such as dumping and distribution, and from wind erosion of deposited wastes, is not easily evaluated by visual observations. The Agency therefore measured ambient asbestos concentrations in the vicinity of the waste disposal area of a large manufacturing and fabricating operation in Ambler, Pennsylvania, and in the vicinity of the tailings disposal area of a large asbestos mill in Hyde Park, Vermont. These concentrations were then compared to the ambient asbestos background concentrations for the respective areas of the sources. Although existing asbestos measurement procedures are reproducible in inter-laboratory comparisons only to within a factor of approximately 5 according to experts, the measured ambient asbestos concentrations analyzed by one laboratory were judged to be useful in making relative determinations of whether asbestos disposal sites are major sources of asbestos emissions.

The individual studies indicate that the asbestos concentrations in the vicinity of the asbestos waste disposal sites are higher than the background levels by a factor of at least 13. The Administrator has thus determined that uncontrolled asbestos waste disposal operations and sites where asbestos waste is deposited are major asbestos emission sources, and is proposing standards for the control of these sources.

Ambient Asbestos Study in Ambler Pennsylvania -- The potential asbestos emission sources that contributed to ambient asbestos concentrations monitored during the study in Ambler, Pennsylvania, are two asbestos manufacturing plants (Plants A and B) and their active and inactive waste disposal sites.

Plant A manufactures high- and low-density monolithic asbestos-cement board and gasket material. The manufacturing of boards and gasket material is performed at Building #1, and the high-density monolithic boards are transported to Building #2 for grinding and finishing (Figure 5-1). Waste generated as a dust (40 percent asbestos) from the sanding of monolithic board at Building #2 is collected in baghouses. The dust is transferred from the baghouse to containers where the material is wetted, covered, and transported to a settling pond about one kilometer away.

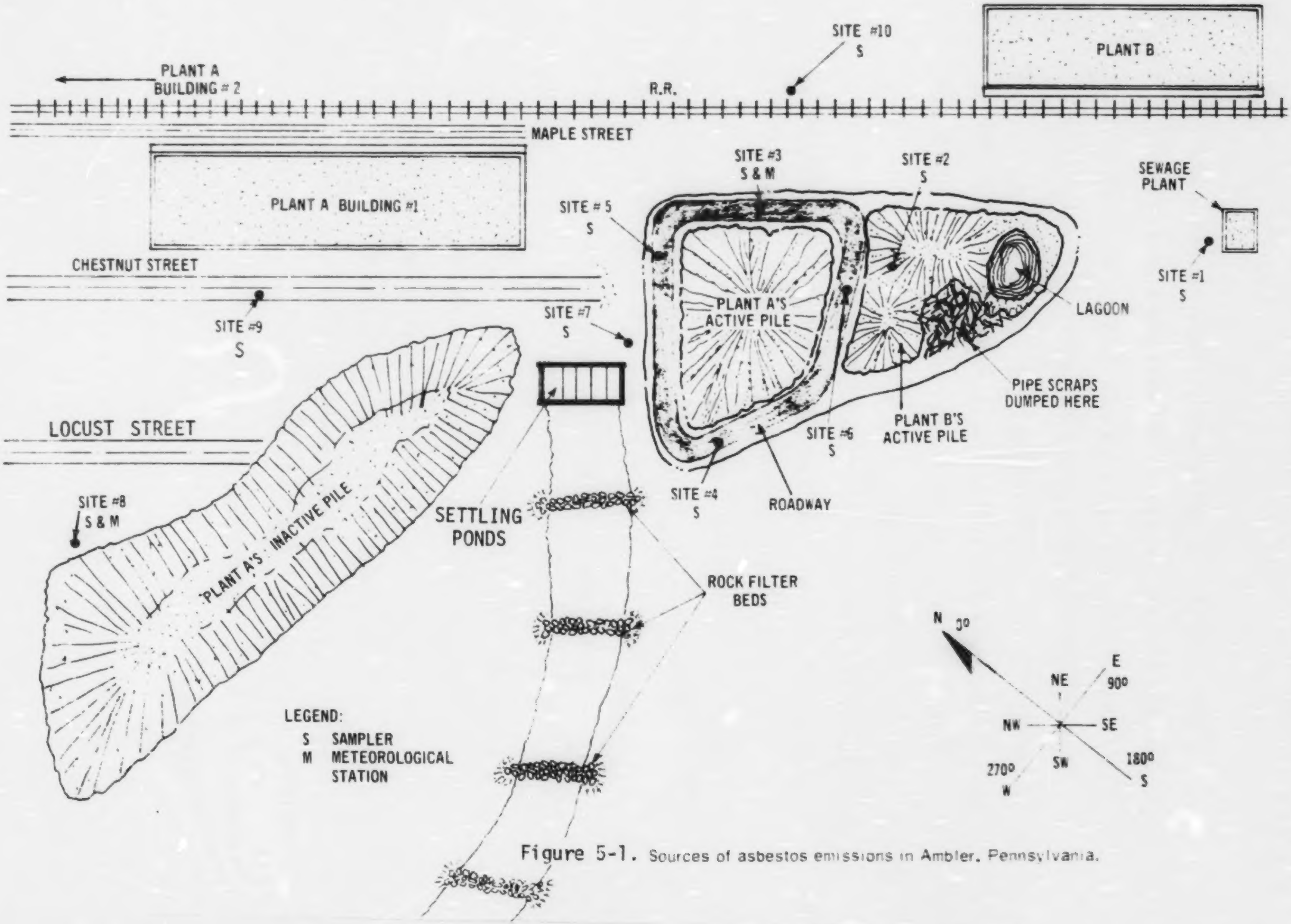
PLANT A
BUILDING # 2
R.R.
SITE #10
S
PLANT B
MAPLE STREET
PLANT A BUILDING #1
SITE #3
S & M
SITE #2
S
SEWAGE
PLANT
SITE # 5
S
SITE #1
S
CHESTNUT STREET
PLANT A'S
ACTIVE PILE
LAGOON
SITE #9
S
SITE #7
S
PIPE SCRAPS
DUMPED HERE
PLANT B'S
ACTIVE PILE
SITE #6
S
LOCUST STREET
SITE #4
S
ROADWAY
SITE #8
S & M
SETTLING
PONDS
PLANT A'S INACTIVE PILE
ROCK FILTER
BEDS
N 0°
E
90°
NE
NW
SE
SW
270°
W
180°
S
LEGEND:
S SAMPLER
M METEOROLOGICAL
STATION

Figure 5-1. Sources of asbestos emissions in Ambler, Pennsylvania.

The waste material is dumped into a section of the settling pond, mixed into a slurry, and pumped to the active disposal lagoon approximately 50 meters away. Other asbestos-containing waste generated at the plant empties into a wastewater system and is channeled to the settling pond.

Plant B manufactures various sizes of asbestos-cement pipe that contains 10 to 12 percent asbestos. Waste generated from machining the pipe ends is collected in a baghouse and recycled rather than being discarded as waste. Pipe scraps greater than 30 cm (ca. 12 inches) in diameter are not recycled, and this waste is transported to the disposal pile. A large amount of asbestos-containing sludge is created in the wastewater treatment operation recently installed by Plant B. Tank trucks transport the slurried sludge to the disposal lagoon; each truck carries approximately 23,000 liters (ca. 6000 gallons) per load and empties into the lagoon at a rate of about 10 to 12 truckloads per 6-week period. When enough water has evaporated, the semidry waste is shoveled from the lagoon and piled onto the adjacent disposal area. A bullodzer then crushes the discarded pipe, the semidried sludge is mixed with the crushed pipe, and the mixture is spread uniformly on the disposal pile. The crushing operation is performed for approximately 1-1/2 days of an 8-week period.

The active disposal sites of Plants A and B are adjoining. Plant A's site is approximately 20 meters high, 90 meters wide, and 150 meters long (ca. 60 feet high, 300 feet wide, and 500 feet long), while Plant B's site is approximately 6 meters high, 90 meters wide, and 210 meters long.

After water evaporates from Plant A's disposal lagoon, portions of the lagoon have a dry, cracked crust. The top layer is light in color, has a relatively low density, and is fibrous. The fibers appear to be bound securely enough so that they are not released by wind action alone. The sides of the disposal site are about 46 cm higher than the level of the lagoon and form a roadway approximately 4.5 meters wide. Solid material is deposited and spread on this roadway when it becomes necessary to build up the sides of the lagoon. Plant B's active waste disposal site is similar to Plant A's.

A waste disposal site located southwest of Plant A has been inactive for about 4 years and covers approximately 40,000 m^2 (ca. 10 acres) (Figure 5-1). The type of waste material deposited at the site differs from the material currently being disposed of at Plant A's active site. Trees, grass, shrubs, and weeds cover approximately 75 to 90 percent of the surface area, but little vegetation grows on the north bank of the pile, which borders one side of a playground and is close (within 15 meters) to occupied dwellings. This bank is approximately 180 meters long, approximately 15 meters high, and has a slope of about 60 degrees.

A sampling network was designed to measure background concentrations to which the public would be exposed, and to isolate emissions from specific sources at the disposal sites. See Figure 5-1 for locations of the sampling sites. The sampling network was composed of ten ambient air samplers and two meteorological wind data systems. The study was performed on October 15-18, 1973. Sampling times at various sites were 24 hours, 12 hours, 1 hour, and 30 minutes, depending on site locations and operations to be isolated. Table 5-1 summarizes the site location, source of emissions to be isolated, sampling time, wind speed and direction, asbestos concentration, and the ratio (R) of the measured asbestos concentration to the background level. It did not rain during the sampling period, and therefore the measured concentrations do not reflect reduced emissions which could result from wetting of the various operations and piles.

The only activity on Plant B's active disposal pile during testing was a truck dumping scrap pipe onto the pile twice a day. No activity was reported on Plant A's active disposal pile, but residue from polishing construction panels was dumped into a section of the settling pond once a day.

Samples that isolated specific emission sources were selected by using measured wind direction and speed.

The ambient asbestos concentrations listed in Table 5-1 range from 3.1 ng/m^3 (nanograms per cubic meter) to 2600 ng/m^3. The samples obtained were representative of all the potential emission sources except pipe crushing by Plant B, which could not be scheduled during the sampling period. Agency personnel observed the pipe crushing operation on October 1 and 2, 1973, at Plant B's disposal pile. Visible emissions were generated by this operation during approximately 25 percent of the bulldozer operating time,

Table 5-1. SUMMARY OF AMBIENT ASBESTOS MONITORING DATA COLLECTED OCTOBER 15-18, 1973, IN AMBLER, PENNSYLVANIA

	Sample		Meteorological Data		Asbestos Concentration		
Case*	Site**	Nominal Sampling Time (hr)	Wind Speed	Direction	Measured (ng/m^3)	Average (ng/m^3)	R***
1	#1	12	1-13 mph	160°-220°	3.1, 11, 12, 22	12.0	1.0
2	#2	12	2-13 mph	160°-280°	19.0-210.0	114.5	9.6
3	#3	12	2-13 mph	160°-270°	29.0-53.0	41.0	3.4
4	#4	12	2-13 mph	160°-280°	5.5-16.0	10.7	0.9
5	#5	12	2-13 mph	160°-270°	97.0-130.0	113.5	9.5
6	#6	12	7-14 mph	255°-280°	48.0	48.0	4.0
7	#6	12	1-8 mph	90°-270°	160.0	160.0	13.3
8	#7	1, 1/2	1-8 mph	90°-260°	890-2600	1745	145.0
9	#7	12	1-8 mph	90°-270°	1200	1200	100.0
10	#8	12	2-13 mph	160°-280°	7.2-12.0	9.6	0.8
11	#9	24	2-14 mph	160°-280°	13, 23, 27	21	1.8
12	#10	24	2-14 mph	160°-270°	49, 210, 500	253	21.0

*Case description.

1. Background ambient concentration.
2. Windblown emissions from Plant B's active waste disposal pile.
3. Windblown emissions from Plant A's active pile.
4. Windblown emissions from Plant A's active disposal pile banks and roadways.
5. Windblown emissions from both Plant A's and B's active disposal piles.
6. Windblown emissions from Plant A's active disposal pile.
7. Windblown emissions from Plant B's active disposal pile.
8. Emissions from dumping of polishing and grinding wastes into settling pond.
9. Emissions from wetting and mixing of polishing and grinding wastes.
10. Windblown emissions from Plant A's inactive tailings pile near children's playground.
11. Windblown emissions from Plant A's active disposal site and truck traffic.
12. Emissions from both active disposal piles.

**Sample site description.

1. Sewage disposal plant - background, sampler.
2. Plant B's active pile, sampler.
3. East sector of Plant A's pile, sampler, meteorological station.
4. West sector of Plant A's pile, sampler.
5. North sector of Plant A's pile, sampler.
6. South sector of Plant A's pile, sampler.
7. Plant A's settling pond, sampler.
8. Playground on Locust Ave., sampler, meteorological station.
9. South Chestnut Street, sampler.
10. Far east, street side of railroad tracks, sampler.

$$***R = \frac{\text{aver. concentration at site}}{\text{aver. concentration at background}}$$

(site #1 in this study)

and the generated dust settled quickly. Maximum emissions were 15 percent opacity, but averaged approximately 5 percent opacity. Once during the crushing operation, for a period of 15 seconds, visible emissions were observed to go beyond the boundary of the disposal site.

Ambient Asbestos Study in Hyde Park, Vermont--The potential asbestos emission sources monitored during the study in Hyde Park, Vermont, are mines and mine roads, ore storage areas near the mill, ore crushing operations, the asbestos mill, mill tailings piles, and non-plant roadways surfaced with mill tailings.

Emissions of asbestos from the mill are covered by the asbestos standard, but the mill was operating under a waiver of compliance during the ambient air study. The mill operations under waiver were the dry-rock storage building, ore dryers, and all except one of the tailings conveyor transfer points.

The asbestos ore is mined in two open-pit quarries. The ore is then transported by trucks approximately 1 kilometer to the location where it is crushed and subsequently deposited by a conveyor onto an exterior wet-ore storage pile. The crushed ore is charged into the dryers as needed and then conveyed to the dry rock storage building. In the milling process, dried crushed ore is processed through a series of screens and aspirators where the asbestos fibers are separated and removed from the ore. The rocks and dust remaining after the milling operation are conveyed to the tailings pile for disposal.

Four power shovels and two bulldozers are used to load the trucks with either ore or waste rock in the quarries. Three ore trucks serve each shovel when the mine is in operation (8:00 a.m. to 12:00 midnight during the sampling program). The loaded trucks travel an average of 650 meters from the quarries to the mill over mine roads. The roads have a minimum width of 10 meters and a maximum grade of 8 percent. During the summer, a 1.5 cm -thick layer of mill tailings is applied to the mine roads for surfacing, and during the winter the same material is added to improve traction over icy roads.

Ore which has passed through the primary and secondary crushers is stored in an open area called the wet-rock storage area prior to being dried. The capacity of the storage area is approximately 68,000 metric tons (ca. 75,000 tons) of ore. The ore is moved continuously from storage to the dryer by vibrating feeders which are located beneath the surface of the pile. The majority of emissions from the storage area probably occur when the ore drops from the end of a conveyer belt to the surface of the storage area approximately 4.5 meters below; however, wind could also entrain emissions from the surface of the pile. A bulldozer moves the rock fairly continuously while the conveyer is in operation to keep the area level and to fill the vibrating feeders to ensure a consistent withdrawal rate from the pile.

The opening, screening, aspirating, and packaging of asbestos fibers are carried out in the main section of the mill, which has a capacity of approximately 3,200 metric tons (ca. 3500 tons) of ore per 3-shift day. Material in the mill is transferred either by belt conveyor, gravity, or air stream, depending upon the job being performed. A dust collector (vertical, pressure-bag-type air filter) is used as the final filter for the ventilation and process air streams. The filtered air from the open pressure baghouses is recirculated to the building to conserve heat during the winter. The unit handles air at the rate of 9100 m^3/min (ca. 320,000 cfm) with a 10 cm (ca. 4 inch) w.c. pressure loss.

Ore which has passed through the mill's screens and aspirating hoods is transported to the tailings pile by conveyors. The tailings pile has been in use for over 15 years and contains approximately 20 million metric tons of tailings. The tailings pile is approximately 120 meters high and 240,000 m^2 (ca. 60 acres) in area. Several potential emission sources from the tailings pile are: conveyor transfer points, vehicle traffic on the pile, the deposit of tailings from the conveyor belt onto the pile, distribution of tailings on the pile with a bulldozer, and wind erosion. The leading edge of the tailings pile is the portion that is most susceptible to windblown emissions. The lower, older part of the pile was observed to have a light crust and did not appear to contain finely divided dust.

A sampling network was designed to measure background concentrations to which the public is exposed and to isolate emissions from specific sources of asbestos emissions in the vicinity of the mine-mill complex.

See Figure 5-2 for locations of the sampling sites. The sampling network was composed of ten ambient air samplers and five meteorological wind data systems. The study was performed September 25 through October 1, 1973. Sampling times at various sites were 12 hours and 4 hours, depending on site locations and operations to be isolated. Table 5-2 summarizes the site location, source of emissions to be isolated, sampling time, wind speed and direction, asbestos concentration, and the ratio (R) of the measured asbestos concentration to the background level. Table 5-3 lists the specific data for asbestos ambient concentrations from only the tailings pile; from the tailings pile, conveyor transfer points, and disposal of the tailings; and along a public roadway off plant property. Table 5-4 presents the asbestos concentration of solid material samples taken from the roadway, ore storage areas, and mill tailings. Asbestos concentrations are presented both for the material as obtained and for the fraction of the material that passes through a minus 140 mesh screen. This fraction is of particular interest because particles of this size can be entrained by moderate wind speeds.

It did not rain during the sampling period; therefore, the measured concentrations do not reflect reduced emissions which could result from wetting of the various operations and piles. The testing program was completed without any major problems. On September 29, 1973, the plant agreed to close down certain operations

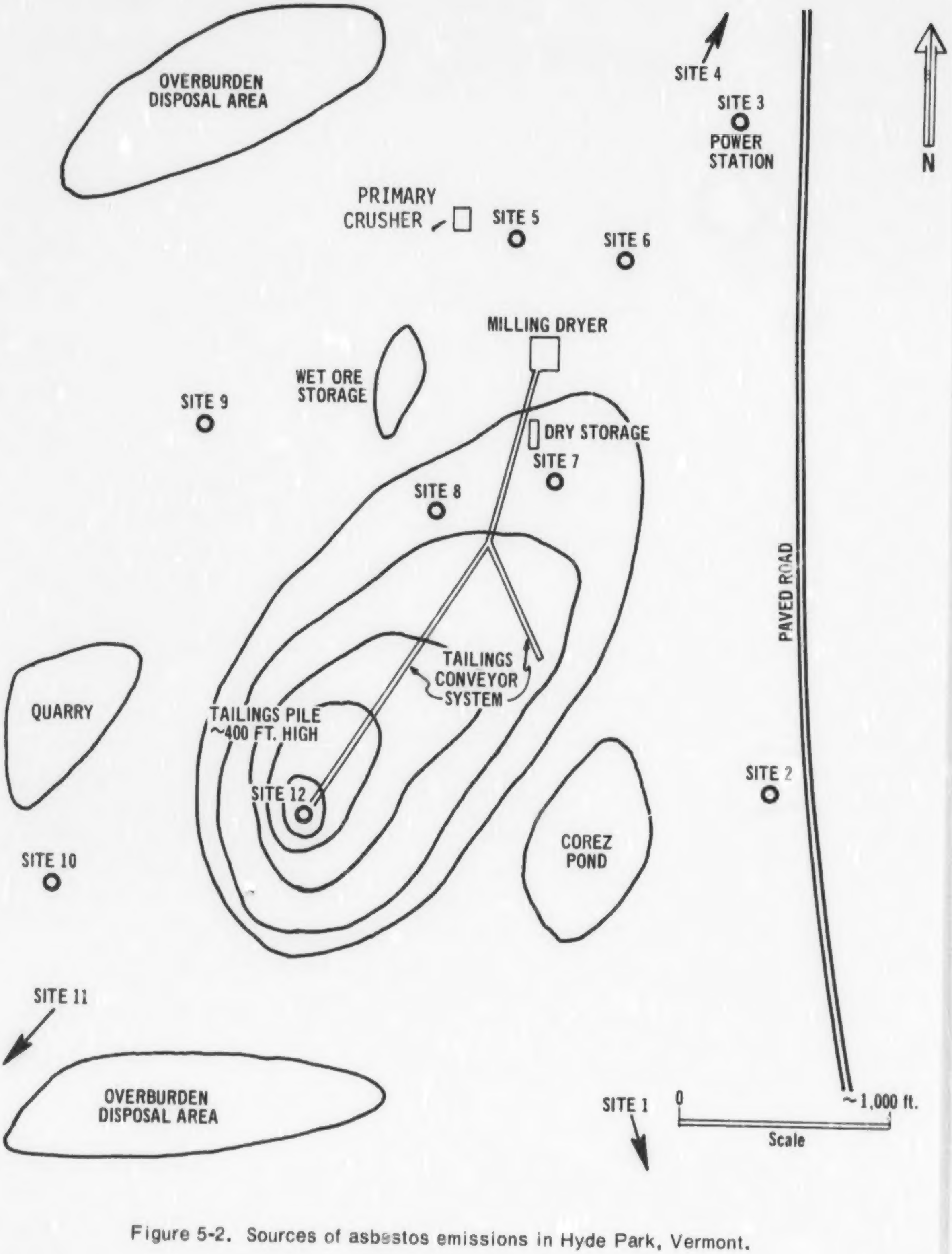
OVERBURDEN DISPOSAL AREA
SITE 4
SITE 3
POWER STATION
N
PRIMARY CRUSHER
SITE 5
SITE 6
MILLING DRYER
WET ORE STORAGE
SITE 9
DRY STORAGE
SITE 7
SITE 8
PAVED ROAD
TAILINGS CONVEYOR SYSTEM
QUARRY
TAILINGS PILE ~400 FT. HIGH
SITE 12
SITE 2
COREZ POND
SITE 10
SITE 11
OVERBURDEN DISPOSAL AREA
SITE 1
0
~1,000 ft.
Scale

Figure 5-2. Sources of asbestos emissions in Hyde Park, Vermont.

Table 5-2. SUMMARY OF AMBIENT ASBESTOS MONITORING DATA COLLECTED SEPTEMBER 25-OCTOBER 1, 1973, IN HYDE PARK, VERMONT

		Meteorological Data		Asbestos Concentration		
Case*	Sample Site**	Wind Speed	Direction	Range (μg/m³)	Average (μg/m³)	
1	#1	2-8 mph	340° - 40°	0.012 - 0.180	0.096	
2	#1	2-7 mph	90° - 270°	0.002 - 0.02	0.008	
3	#2	2-8 mph	250° - 295°	0.05 - 1.5	0.445	
4	#2	6-9 mph	250° - 295°	0.15	0.15	
5	#3	1-7 mph	200° - 230°	0.12 - 13.6	7.35	9
6	#3	6-9 mph	183° - 247°	4.2	4.20	5
7	#3	4-8 mph	200° - 275°	1.6 - 13.6	6.57	8
8	#4	3-11 mph	190° - 230°	1.3 - 13.1	4.14	5
9	#4	3-6 mph	208° - 220°	0.03	0.03	
9A	#1 & #4	1-5 mph	135° - 180° @1 360° - 45° @4	0.002 - 0.4	0.067	
10	#5	3-10 mph	140° - 210°	0.24 - 10.8	5.15	6
10A	#5	1-3.5 mph	90° - 270°	5.2	5.2	6
11	#6	3-10 mph	200° - 230°	1.9 -106.5	33.56	4,1
12	#6	1-9 mph	220° - 310°	0.03 - 50.0	18.81	2,3
13	#6	1-3 mph	100° - 150°	0.71 - 8.1	3.78	4
14	#7	3-11 mph	202° - 18°	0.03 - 67.6	22.5	2,8
15	#7	5-13 mph	210° - 30°	4.78 - 46.1	24	3,0
16	#8	3-10 mph	210° - 120°	0.06 - 7.6	3	3
17	#8	3-5 mph	350° - 60°	5.2 - 22.9	9.76	1,1
18	#10	1-5 mph	30° - 90°	0.25 - 1.1	0.54	
19	#11	1-5 mph	30° - 90°	0.14 - 0.94	0.53	
A	2 & 8	-	-	0.06 - 1.2	0.410	
B	2 & 8 & 10	-	-	0.05 - 7.6	2.091	2
C	1 - 4	-	-	0.002 - 13.6	2.33	2

Table 5-2 (continued). SUMMARY OF AMBIENT ASBESTOS MONITORING DATA COLLECTED SEPTEMBER 25-OCTOBER 1, 1973, IN HYDE PARK, VERMONT

*Case Description

Case 1	Windblown emissions from mine-mill complex
Case 2	Background samples
Case 3	Windblown emissions from tailings pile with conveyor system operating
Case 4	Windblown emissions from tailings pile with conveyor system not operating
Case 5	Windblown emissions from tailings pile, wet-rock storage, and mill with mill operating
Case 6	Windblown emissions from tailings pile and wet-rock storage with mill, primary crusher, and ore dryer shut down
Case 7	Windblown emissions from tailings pile and mill with primary crusher not operating
Case 8	Windblown emissions from tailings pile, wet-rock storage, mill, and ore dryer with mill operating
Case 9	Windblown emissions from tailings pile and wet-rock storage with mill, primary crusher, and ore dryer shut down
Case 9A	Emissions from roadways off plant property
Case 10	Windblown emissions from roadways, tailings pile, ore dryers, mill, and wet-rock storage
Case 10A	Windblown emissions from primary crusher and its conveyor
Case 11	Windblown emissions from tailings pile, mill, ore dryer and wet-rock storage
Case 12	Windblown emissions from wet-ore storage and primary crushing operation
Case 13	Ambient asbestos concentrations in and around working areas
Case 14	Windblown emissions from tailings pile and conveyors
Case 15	Windblown emissions from mill, ore dryer, and dry-rock storage area
Case 16	Windblown emissions from tailings pile
Case 17	Windblown emissions from mill, drying, and crushing operations
Case 18	Windblown emissions from tailings pile and milling complex
Case 19	Windblown emissions from tailings pile and milling complex
Case A	Windblown emissions from only the tailings pile
Case B	Windblown emissions from tailings pile, plus emissions from tailings conveyor transfer points, plus emissions from dumping of tailings.
Case C	Ambient concentrations measured along public roadway off plant property

**Site Description

Site 1	C. Jones Barn	Site 7	Dry Storage
Site 2	Corez Pond	Site 8	Quarry Road
Site 3	Power Substation	Site 9	Lowell Quarry
Site 4	Far North	Site 10	Disposal Area
Site 5	Equipment Storage	Site 11	Far South
Site 6	Working Area	Site 12	Top of Tailings Pile

$$***R = \frac{\text{aver. concentration at site}}{\text{aver. concentration at site \#1 (background)}}$$

Table 5-3. AMBIENT ASBESTOS CONCENTRATIONS FROM TAILINGS PILE AND ON PUBLIC ROADWAY

Case A

Windblown emissions from only the tailings pile.

Location	Date	Time (hr)	Asbestos Conc. (ng/m^3)
Site 2	9/30/73	1200-1600	150
Site 8	10/1	0800-1200	400
Site 8	10/1	1200-1600	1200
Site 8	10/1	0000-0400	240
Site 8	10/1	0400-0800	60

Case B

Windblown emissions from tailings pile, plus emissions from tailings conveyor transfer points, plus emissions from dumping of tailings.

Location	Date	Time (hr)	Asbestos Conc. (ng/m^3)
Site 2	9/26/73	1200-1600	90
Site 2	9/26	1600-2000	50
Site 2	9/27	1600-2000	140
Site 2	9/28	1200-1600	1500
Site 8	9/27	0400-0800	5600
Site 8	9/27	0800-1200	2500
Site 8	9/28	2000-2400	6500
Site 8	10/1	0800-1200	400
Site 8	10/1	1200-1600	1200
Site 8	10/1	1600-2000	7600
Site 10	9/28	0000-0400	260
Site 10	9/28	0800-1200	1100
Site 10	9/30	0000-0400	250

Table 5-3 (continued). AMBIENT ASBESTOS CONCENTRATIONS FROM TAILINGS PILE AND ON PUBLIC ROADWAY

Case C

Ambient concentrations measured along public roadway off plant property

Location	Date	Time (hr)	Asbestos Conc. (ng/m^3)
Site 1	9/28/73	0000-1200	12
Site 1	9/29	1200-2400	180
Site 1	9/26	0000-1200	5
Site 1	9/26	1200-2400	2
Site 1	9/27	0000-1200	15
Site 1	9/29	0000-1200	20
Site 1	10/1	0000-1200	3
Site 1	10/1	1200-2400	4
Site 2	9/26	1200-1600	90
Site 2	9/26	1600-2000	50
Site 2	9/27	1600-2000	140
Site 2	9/28	1200-1600	1500
Site 2	9/30	1200-1600	150
Site 2	9/30	0400-0800	2600
Site 2	9/28	1600-2000	180
Site 2	9/27	0400-0800	40
Site 2	9/27	0800-1200	70
Site 2	10/1	0000-0400	50
Site 2	10/1	0400-0800	70
Site 2	10/1	0800-1200	20
Site 2	10/1	1200-1600	83
Site 2	10/1	1600-2000	170
Site 3	9/26	0000-0400	2000
Site 3	9/26	0800-1200	4500
Site 3	9/26	1200-1600	12,700
Site 3	9/27	0000-0400	120
Site 3	9/27	1200-1600	8300
Site 3	9/27	1600-2000	13,100
Site 3	9/29	0400-0800	4500
Site 3	9/29	0800-1200	13,600
Site 3	9/30	1200-1600	4200
Site 3	9/29	1200-1600	1600
Site 3	9/30	0400-0800	2100
Site 4	9/28	0000-0400	13
Site 4	9/29	2000-2400	400
Site 4	9/26	0000-0400	1300
Site 4	9/26	0800-1200	1900
Site 4	9/26	1200-1600	2500
Site 4	9/27	0000-0400	1500
Site 4	9/27	1200-1600	3500
Site 4	9/27	1600-2000	6500

Table 5-3 (continued). AMBIENT ASBESTOS CONCENTRATIONS FROM TAILINGS PILE AND ON PUBLIC ROADWAY

Location	Date	Time (hr)	Asbestos Conc. (ng/m^3)
Site 4	9/29/73	0400-0800	13,100
Site 4	9/29	0800-1200	2800
Site 4	9/30	1200-1600	30
Site 4	9/28	0400-0800	22
Site 4	9/29	2000-2400	400
Site 4	9/28	0800-1200	14
Site 4	9/30	0400-0800	8400
Site 4	9/30	0800-1200	150
Site 4	9/30	0000-0400	1800

Table 5-4. ASBESTOS CONCENTRATION OF MATERIAL SAMPLES TAKEN IN VERMONT

Sample #	Site Description	% of Sample Represented by -140 Mesh Fraction	% Chrysotile in Unfractionated Sample	% Chrysotile in -140 Mesh Fraction
72	From road just above site #10 test	2.0	0.2	4.2
73	Wet-ore storage	2.4	0.4	15.8
74	-1/2" + 10 mesh tailings (used in asphalt pavement)	0.2	0.02	33.4
75	1/4" tailings gravel for sale (used to sand highways)	0.2	0.1	24.1
76	Dry-rock storage site #7	10.7	1.0	12.7
82	Dry storage area site #12	10.8	2.0	21.1

to enable the isolation of potential asbestos windblown emissions from the tailings pile.

The sampling sites were located to isolate specific emission sources and also to have background samples for each specific emission source. After the meteorological data and the plant operations data were checked, samples were selected which represented emissions from specific sources. For more information on the selection of sampling sites and validation of selected samples, refer to Table 5-5.

Table 5-5. LOCATION OF SAMPLING SITES

Site 1 - In order to determine background ambient asbestos concentrations, a sampler was placed at Mr. Jones' barn. Mr. Jones' barn is approximately 1.5 kilometer SE of the mill, with prevailing winds from the S-SW, the ambient concentrations obtained were representative background levels.

Site 2 - The Corez Pond location was selected as a sampling site to measure windblown emissions from the tailings pile. With a westerly wind, emissions from the mill were excluded and only emissions from the tailings pile measured.

Site 3 - In order to measure windblown emissions from the entire mine-mill complex, samplers were placed on the northern side of the mine-mill complex. With the wind prevailing from the S-SW, the power substation was directly upwind from the mine-mill complex.

Site 4 - A sampler was put at site 4 because, although this location was also directly upwind from the mine-mill complex, it was more removed from the mine-mill than site 3. By selecting samples taken at site 4 with samples taken at site 3 at corresponding times, the dispersion or fallout of emissions from the mine-mill complex could be determined.

Table 5-5 (continued). LOCATION OF SAMPLING SITES

Site 5 - A sampler was placed at the Foundry Building to measure the emissions from the primary and secondary crushers and also from the wet-ore storage pile. The crushers and ore storage pile are very close to each other, which caused difficulty in distinguishing the individual emissions.

Site 6 - A sampler near the Engineering Drafting Building measured fallout emissions from the two ore dryer stacks. At this site, the ambient asbestos concentration inhaled by workers in this area was measured.

Site 7 - The main objectives in placing a sampler on the tailings pile near the dry storage area were to measure windblown emissions from the tailings pile and emissions from the ventilation system of the dry-rock storage building.

Site 8 - This sampler measured windblown emissions from the side of the asbestos tailings pile and served as background for samples obtained at site 2.

Site 10 - This sampler measured windblown emissions from the mill and tailings pile, and also served as background for samples taken at sites 3 and 4.

Site 11 - This sampler measured background asbestos concentrations and emissions from blasting in the quarries.

6. MERCURY EMISSIONS FROM SLUDGE INCINERATION AND DRYING FACILITIES

SUMMARY OF PROPOSED AMENDMENT

Emissions to the outside air from sludge incineration plants, sludge drying plants, or a combination of these that process wastewater treatment plant sludges shall not exceed 3200 grams of mercury per 24-hour period.

RATIONALE FOR PROPOSED AMENDMENT

Disposal of wastewater treatment plant sludge is a responsibility of all major and many smaller municipalities and also various industries that choose to dispose of their own wastewater treatment plant sludge. In the majority of cases, raw waste is transported to centralized wastewater treatment plants, where various waste treatment methods are used to process the raw waste into sludges that must be disposed of in the environment--via land, water, air, or a combination of these media. Mercury emissions result from the incineration and drying of sludge that contains small quantities of mercury.

At the time of proposal and promulgation of the national emission standard for mercury [March 31, 1971 (36 FR 23239), and April 6, 1973 (38 FR 8820), respectively], available information indicated that sewage sludge incineration plants did not emit mercury in a manner that could cause the ambient concentration to exceed the inhalation health effects limit of 1 microgram per cubic meter averaged over a 30-day period. Consequently, the Administrator determined at that time that it was not necessary to regulate mercury emissions from this category of sources in order to protect public health with an ample margin of safety. At the time of promulgation, information available to the Agency included mercury stack emission tests at five sewage sludge incineration plants. Of the five emission rates determined, the maximum was 125 grams of mercury per day based on one test which was later judged to be invalid on the basis of mercury mass balance calculations. Emissions for the remaining four tests ranged from 1 to 40 grams of mercury per day.

After promulgation of the national emission standard for mercury, questions concerning the impact on public health of mercury emissions from sewage sludge incinerators were raised by the Environmental Defense Fund, et al., in their Petition for Review of the national emission standards for hazardous air pollutants. Similar questions arose in connection with proposals to construct several large sludge incineration facilities. In response, the Agency initiated a study to more completely characterize emissions of mercury from sewage sludge incinerators (see Appendix D).

The results from one of two stack tests that were performed during the more recent investigation are available. The emission results from this test and the four former tests suggest that a significant quantity of mercury is collected by water scrubbers.

Mercury is emitted from the drying of sludge and the incineration of industrial wastewater sludge, as well as from the incineration of municipal sludges. There are approximately 280 municipal sludge incineration sites, 17 sludge drying sites, and an undetermined number of industrial waste sludge incineration sites in the U.S. The pretreatment of industrial wastewater streams to remove mercury before discharge into municipal wastewater treatment streams may be required in the future. This could produce industrial sludges--which might be incinerated--with higher concentrations of mercury than either municipal or combined municipal-industrial wastewater treatment plant sludges. Mercury concentrations of sewage sludges nationally average about 5 ppm on a dry solids basis; however, approximately 10 percent of the sludge samples have mercury concentrations in excess of 15 ppm.

Very large sludge incineration facilities are being contemplated for the future; for example, one existing facility will in the near future incinerate 900,000 kg (ca. 2 million pounds) of dry solids per day. If sludge with the highest reasonably expected mercury content of 15 ppm (parts per million) were incinerated, and if only 50 percent of the mercury in the sludge were emitted into the atmosphere, the plant would emit 6,800 grams of mercury per day. This amount is over twice the maximum allowable mercury emissions that will protect the public health with an ample margin of safety. Sludge incineration facilities with capacities of 1,800,000 kg (ca. 4,000,000 pounds) per day are being planned for operation in 2005.

In view of the potentially large mercury emissions from sludge incineration plants, the Administrator has determined that it is prudent to regulate mercury emissions from this category of sources. While no sludge incineration facilities are known to be exceeding the proposed mercury emission limitation at this time, the proposed standard will prevent a mercury emission problem from occurring in the future by ensuring that new and modified facilities investigate and provide for limiting potential mercury emissions prior to construction.

The proposed emission limit of 3200 g/day was derived from dispersion estimates as the level which would protect against the violation of an ambient mercury concentration of 1 microgram per cubic meter averaged over a 30-day period. The meteorological estimating procedure is the same as that used to develop standards for mercury ore processing facilities and mercury chlor-alkali plants (38 FR 8820), except that emission release conditions representative of sludge incineration sites are used. The assumptions and equations used to make the dispersion estimates are discussed in Appendix C of this report.

Both the original national emission standard for mercury and the proposed amendments are designed to control the concentration of mercury in the ambient air adjacent to the point source. Since the standard is concerned primarily with the threat posed by inhalation of mercury in air immediately proximate to the point source, it does not deal with the potential long-range hazard posed by the addition of mercury from these point sources to the total environmental burden. Not addressed, for example, is the mercury discharged from chlor-alkali, ore processing, and sludge incineration plants that can eventually be transported to water systems where it may potentially be methylated and bioconcentrated in fish. The Agency has become increasingly concerned about the total environmental burden of mercury, however, and is initiating studies to determine how this aspect can most effectively be addressed under the provisions of the Clean Air Act and other authorities.

Description of Industry

Raw waste originates from a variety of sources which can be roughly classified into the major categories of industrial and residential sources. The raw waste is transported to wastewater treatment plants. Primary treatment of raw waste is designed to remove the bulk of the non-dissolved solids present. In many cases the wastewater remaining after primary treatment is given secondary and, in a few cases, tertiary treatment prior to discharge. Sludges produced by primary treatment can be combined with secondary and tertiary sludges prior to final disposal.

Average characteristics of dry sewage sludge solids[1] range from 30.2 to 88.5 percent combustibles, from 11.5 to 69.8 percent ash, and from 9,300 cal/g (ca. 16,750 Btu/lb) for grease and scum to 2,220 cal/g (ca. 4,000 Btu/lb) for grit. Characteristics of both raw and digested sludge fall within these ranges. Table 6-1 presents the average characteristics of various sewage sludges. Sludge characteristics, such as dryness of solids, percent combustibles, and percent ash, can be modified significantly by the addition of filter aids, such as lime, ferric chloride, and polymers.

Prior to incineration, concentrations of elements and materials in sewage sludge are usually expressed on a dry solid basis. Dry solids are also called total residue. The residue after incineration is called ash, or fixed solids. The laboratory method for determining dry solids (total residue) and ash (fixed solids) is described by American Public Health Association (APHA), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF).[2]

Sludge concentration data from approximately 42 sewage treatment plants indicate a range of mercury content on a dry solids basis from 0.6 ppm to 43 ppm; the average value is 4.9 ppm. Table 6-2 lists the individual values of mercury concentration in sewage sludges. The upper limit would be 90 ppm, but 90 ppm and three other values from Bergen County and Joint Meeting, New Jersey, in October 1971 seemed inordinately high compared to the other values in the table. Additional sludge samples obtained from these same facilities in November 1973 averaged 9.2 ppm as compared to the October 1971 average of 75.5 ppm. It is concluded that the October 1971 values are erroneous due to sampling or analytical errors.

Table 6-1. AVERAGE CHARACTERISTICS OF SEWAGE SLUDGE[1]

Material	Combustibles (%)	Ash (%)	Heat Content (cal/g)	Heat Content (Btu/lb)
Grease and scum	88.5	11.5	9300	(16,750)
Raw sewage solids	74.0	26.0	5710	(10,285)
Fine screenings	86.4	13.6	4990	(8,990)
Ground garbage	84.8	15.2	4580	(8,245)
Digested sewage solids and ground garbage	49.6	50.4	4450	(8,020)
Digested sludge	59.6	40.4	2940	(5,290)
Grit	30.2	69.8	2220	(4,000)

Table 6-2. MERCURY CONCENTRATION IN SEWAGE SLUDGES, DRY SOLIDS BASIS

Data No.	Sewage Treatment Plant Location	Date of Collection	Mercury, ppm
1	Chicago, Illinois[3]	3/18/71	4.6
2	Chicago, Illinois	3/19/71	4.8
3	Chicago, Illinois	3/22/71	4.8
4	Chicago, Illinois	3/23/71	4.7
5	Chicago, Illinois	3/24/71	4.6
6	Chicago, Illinois	3/25/71	4.7
7	Greensboro, North Carolina[4]	7/71	6.5
8	San Lorenzo, California	7/71	5.6
9	San Mateo, California	7/71	5.0
10	Edmonds, Washington	7/71	3.8
11	Morristown, Pennsylvania	7/71	6.0
12	Lynwood, Washington	7/71	5.3
13	Tahoe, California	7/15/71	5.5
14	Tahoe, California	7/15/71	5.5
15	Tahoe, California	7/15/71	5.7
16	Tahoe, California	7/15/71	12.0
17	Tahoe, California	7/15/71	15.0
18	Tahoe, California	7/15/71	7.5
19	Tahoe, California	7/16/71	7.5
20	Barstow, California	7/21/71	5.5
21	Barstow, California	7/21/71	5.5
22	Barstow, California	7/22/71	5.5
23	Lorton, Virginia	7/71	4.6
24	Lorton, Virginia	7/71	2.6
25	Lorton, Virginia	7/71	2.0
26	Lorton, Virginia	8/5/71	1.9
27	Lorton, Virginia	8/5/71	4.0
28	Cincinnati, Ohio	8/20/71	6.0
29	Cincinnati, Ohio	8/20/71	3.6
30	Dayton, Ohio	8/25/71	11.5
31	Indianapolis, Indiana	8/23/71	4.2
32	Indianapolis, Indiana	8/23/71	3.0
33	Indianapolis, Indiana	8/23/71	3.6
34	Monterey, California	10/14/71	8.6
35	Monterey, California	10/14/71	9.0
36	Bergen County, New Jersey	10/26/71	88.0*
37	Bergen County, New Jersey	10/26/71	90.0*
38	Bergen County, New Jersey	10/26/71	50.0*
39	Passaic Valley, New Jersey	11/1/71	3.9
40	Middlesex County, New Jersey	10/25/71	4.9
41	Joint Meeting, New Jersey	10/27/71	74.0*

*See text, page 78 for discussion of these values.

Table 6-2 (continued). MERCURY CONCENTRATION IN SEWAGE SLUDGES, DRY SOLIDS BASIS

Data No.	Sewage Treatment Plant Location	Date of Collection	Mercury, ppm
42	Northwest Bergen County, New Jersey	11/18/72	8.0
43	Northwest Bergen County, New Jersey	11/18/72	12.0
44	Cedar Rapids, Iowa	2/22/72	0.6
45	Cincinnati, Ohio	1/24/72	3.0
46	Cincinnati, Ohio	1/25/72	1.0
47	Cincinnati, Ohio	1/26/72	2.0
48	Cincinnati, Ohio	4/3/73	6.0
49	Cincinnati, Ohio	4/3/73	4.0
50	Dayton, Ohio	4/4/73	15.0
51	Columbus, Ohio	2/27/73	6.0
52	Columbus, Ohio	2/27/73	8.0
53	Columbus, Ohio	2/27/73	10.5
54	Columbus, Ohio	2/27/73	7.0
55	Columbus, Ohio	2/26/73	13.0
56	Columbus, Ohio	2/27/73	11.0
57	Columbus, Ohio	2/27/73	11.0
58	Piscataway, Maryland[5]	8/3/73	0.83
59	Piscataway, Maryland	8/9/73	1.54
60	(City Unknown), Indiana[6]	Unknown	2.8
61	(City Unknown), Indiana	Unknown	5.2
62	(City Unknown), Indiana	Unknown	1.0
63	(City Unknown), Indiana	Unknown	2.3
64	(City Unknown), Indiana	Unknown	13.2
65	(City Unknown), Indiana	Unknown	1.8
66	(City Unknown), Indiana	Unknown	2.0
67	(City Unknown), Indiana	Unknown	4.6
68	(City Unknown), Indiana	Unknown	1.8
69	Kansas City, Missouri	Unknown	5.0
70	Kansas City, Missouri	Unknown	3.0
71	Sioux City, Iowa	Unknown	5.0
72	Joplin, Missouri	Unknown	43.0
73	Grand Island, Nebraska	Unknown	26.0
74	Jefferson City, Missouri	Unknown	5.0
75	N.W. Bergen Co., Waldwick, New Jersey[7]	11/12/73	5.9
76	N.W. Bergen Co., Waldwick, New Jersey	11/13/73	3.6
77	N.W. Bergen Co., Waldwick, New Jersey	11/13/73	3.9
78	N.W. Bergen Co., Waldwick, New Jersey	11/13/73	7.3
79	N.W. Bergen Co., Waldwick, New Jersey	11/13/73	5.8
80	Joint Meeting, Elizabeth, New Jersey[8]	11/13/73	14.5
81	Joint Meeting, Elizabeth, New Jersey	11/13/73	11.6
82	Joint Meeting, Elizabeth, New Jersey	11/14/73	8.6

Table 6-2 (continued). MERCURY CONCENTRATION IN SEWAGE SLUDGES, DRY SOLIDS BASIS

Data No.	Sewage Treatment Plant Location	Date of Collection	Mercury, ppm
83	Bergen County, Little Ferry, New Jersey	11/13/73	7.1
84	Bergen County, Little Ferry, New Jersey	11/13/73	7.7
85	Bergen County, Little Ferry, New Jersey	11/14/73	5.5
86	Greensboro, North Carolina[9]	12/7/73	4.2
87	Pittsburgh, Pennsylvania	12/73	3.3
88	Pittsburgh, Pennsylvania	12/73	4.8
89	Hartford, Connecticut	12/73	3.7
90	Hartford, Connecticut	12/73	--*
91	New Haven Connecticut	12/73	--*
92	New Haven, Connecticut	12/73	--*
93	Detroit, Michigan	12/73	2.3
94	Detroit, Michigan	12/73	2.6
95	Chicago, Illinois	12/73	--*
96	Chicago, Illinois	12/73	--*
97	Indianapolis, Indiana	12/73	2.3
98	Indianapolis, Indiana	12/73	2.0

*Result not available at present time.

The total input of mercury to an incinerator or dryer may be calculated by multiplying the concentration of mercury in the sludge by the total incinerator sludge incineration or drying rate according to the following equation:

$$I_{Hg} = \frac{C_{Hg} \times I_s}{1 \times 10^3} \qquad (1)$$

where C_{Hg} = concentration of mercury in sludge, ppm dry solids basis

I_s = sludge incineration or drying rate, kg/day dry solids basis

I_{Hg} = mercury incinerator input, grams per day

1×10^3 = conversion

Incineration of sludges involves combustion of greater than 99 percent of the combustible content of the sludges. Drying is the removal of water from sludge by heating it with combustion gases to a temperature above 65°C (ca. 150°F). Flash drying is the almost instantaneous removal of moisture from solids by introduction into a hot gas stream.

Temperatures of incineration range from 700 to 980°C (ca. 1300 to 1800°F). Auxiliary heat or fuel requirements to maintain these temperatures depend upon the combination of moisture and combustible content of the sludge. Dwell times of sludge at this temperature range from less than 10 seconds in a cyclonic reactor to a much longer time in a multiple-hearth furnace. Inert ash is produced by incineration and this ash is disposed of mainly by landfill, although it is sometimes used in the manufacture of building products. The principal types of sludge incineration systems currently used in the United States are listed below in order of number in use:

1. Multiple-hearth
2. Fluidized bed
3. Flash drying with incineration
4. Wet oxidation
5. Cyclonic reactor

Flash drying is the major sludge drying process used in the United States and consists of the introduction of dewatered sludge

(15 to 25 percent dry solids) into a hot combustion gas stream that is normally maintained at a temperature of 590 to 700°C (ca. 1100 to 1300°F). The sludge is heated to a temperature of approximately 65 to 95°C (ca. 150 to 200°F), and its moisture content is reduced to 8 to 10 percent. The flash-dried sludge can then be used for various purposes, including fuel and fertilizer. Systems have also been designed so that sludge can be dried in modified multiple-hearth incinerators; sludge temperatures are similar to those used for flash drying.

Existing capacities for incineration or drying of sewage sludge range from less than 4,540 kg/day (ca. 10,000 lb/day) to approximately 454,000 kg/day (ca. 1,000,000 lb/day) on a dry solids basis. Table 6-3 presents the distribution of sludge burning capacities of existing plants. The largest known capacities in the U.S. are presented in Table 6-4. Detroit, Michigan, will have the largest existing burning capacity at 862,600 kg/day (ca. 1,900,000 lb/day) and an actual burning rate of 408,600 kg/day (ca. 900,000 lb/day), as reported in Table 6-4. However, Chicago, Illinois, is producing approximately 681,000 kg/day (ca. 1,500,000 lb/day) of dry solids; an average of 408,000 kg/day (ca. 900,000 lb/day) are disposed of on land, and 272,400 kg/day (ca. 600,000 lb/day) are flash-dried to 97 percent dry solids for subsequent use as fertilizer. Based on tests performed at the West-Southwest Treatment Plant in Chicago, approximately 40 percent[10] of the mercury that enters the dryer is volatilized.

Table 6-3. DISTRIBUTION OF EXISTING PLANTS ACCORDING TO SLUDGE BURNING CAPACITIES[a]

Dry solids burning capacity		
(kg/day)	(lb/day)	Number of plants
Less than 4,540	(Less than 10,000)	17
4,540 to 45,400	(10,000 to 100,000)	173
45,400 to 227,000	(100,000 to 500,000)	37
Greater than 227,000	(Greater than 500,000)	6

[a] This tabulation, derived from installation lists of major manufacturers (1973), represents approximately 83 percent of existing plants.

Table 6-4. SLUDGE BURNING CAPACITIES OF LARGEST PLANTS

	Dry Solids Burned			
	Actual		Capacity, Actual Plus Current Construction	
Location	(kg/day)	(ca. lb/day)	(kg/day)	(ca. lb/day)
Detroit, Mich.	408,600	(900,000)	849,900	(1,872,000)
Cleveland, Ohio	136,200	(300,000)	544,800	(1,200,000)
Minn. - St. Paul	272,400	(600,000)	472,160	(1,040,000)
St. Louis, Mo. (Bissell)	76,270	(168,000)	283,750	(625,000)
Louisville, Ky.			272,400	(600,000)
Cincinnati, Ohio			261,500	(576,000)
Pittsburgh, Pa.	108,960	(240,000)	217,920	(480,000)
Indianapolis, Ind.	136,200	(300,000)	181,600	(400,000)
St. Louis, Mo. (Le May)	54,480	(120,000)	170,250	(375,000)
Hartford, Conn.	54,480	(120,000)	163,440	(360,000)
Kansas City, Mo.	54,480	(120,000)	150,270	(331,000)

Raw waste supply to wastewater treatment plants and in turn to incinerators will increase because of increasing population, consolidation of sewer systems, tertiary treatment of sludges, and increasing use of sewerable materials. Direct land disposal, ocean disposal, and incineration and drying of sludges will continue to be used for sludge disposal. An accurate prediction of the favored method of disposal is not possible at this time because of energy and economic considerations and land and water disposal site availability. Table 6-5 shows the estimated sewage sludge incinerator increase through 1980. The figures may be reduced because of energy considerations but are the best estimates at this time. The size distribution of the additional incinerators is expected to be similar to those shown in Table 6-3. Existing sewer systems in the United States and potential future systems could produce large amounts of waste sludge. Estimates of dry solids sewage produced per capita at present range from 95 to 182 g/day. Using the average per capita figure of 136 g/day and assuming a New York City population of 10,000,000 served, 1,362,000 kg/day of sewage sludge on a dry solids basis would be produced. This would require at present an incineration capacity three times as large as any in existence and would require an even larger burning capacity for contingency and future needs. Detroit has long-range plans past the year 2000 for potential burning capacities of approximately 1,816,000 kg/day of dry solids, four times their present capacity. Detroit currently has additional incineration capacity in construction and expects to have total capacity of 908,000 kg/day of dry sewage sludge in operation in 1975. Chicago, the Los Angeles area, and other metro-

Table 6-5. NUMBER OF SEWAGE SLUDGE INCINERATORS, 1970 THROUGH 1980[a]

Year	Number	Comments
1970	200	Manufacturer's estimate
1973	275	Manufacturer's estimate
1975	375	Estimated 30 for 1974 and 70 for 1975
1977	515	Estimated 70/year
1980	725	Estimated 70/year

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[a] Factors such as the availability of alternative methods of sludge disposal and auxiliary combustion energy (when necessary) will have a significant effect on the actual rate of construction.

politan communities produce large amounts of sewage sludge that are not disposed of by incineration at this time but could be in the future. Presently New York City disposes of its sludge in the ocean, and Chicago has the capability to use a variety of treatment and disposal methods.

Large population centers may in the future install much larger incineration capacities than are currently in operation. Although auxillary fuel is a consideration that will tend to discourage the short-term use of sludge incineration, new, more efficient sludge dewatering processes may make incineration more attractive as a sludge disposal method.

Mercury Emissions

As previously stated, stack emissions were tested at seven sewage sludge incineration sites; Table 6-6 summarizes the test data. Results from the Piscataway, Md. plant are not yet available. All sites used a water scrubber particulate emission control device. Operating scrubber pressure drops ranged from 6.4 cm water column (w.c.) (ca. 2.5 in. w.c.) at the Fairfax County, Virginia, incinerator to 145 cm w.c. (ca. 57 in. w.c.) at the Piscataway, Maryland plant. Mercury removal efficiencies of water scrubbers varied from a high of 96 percent at South Lake Tahoe, California, to a low of 68 percent at Waldwick, New Jersey. Data from the Barstow, California, test are considered invalid because they show that a quantity of mercury four times greater than the mercury content of the sludge incinerated was emitted from the stack during the test, indicating a mistake in the sampling or in the handling or analysis of the samples. No correlation has been established between the process or scrubber

Table 6-6. MERCURY EMISSIONS FROM SEWAGE SLUDGE INCINERATION[a,b]

No.	Plant name and address	Date of test	Sewage sludge			Stack test			Hg Collection Efficiency, %	Emission factor (grams Hg emitted/ metric ton of sludge incinerated, dry solids basis)
			kg/day burned during test	Hg, ppm dry solids during test	Hg, g/day to incineration during test	Hg, µg/dscm	Stack flow, dscm/min	Hg, g/day emitted		
1	South Lake Tahoe[12,13] Plant South Lake Tahoe, Ca.	July 15, 1971	3,405	8.2	28.0	21.4	33.8	1.195	96	0.35
2	Barstow Plant[12,14,c] Barstow, Ca.	July 21, 1971	5,176	5.5	25.44	2537.0	34.0	124.1	-	-
3	Fairfax County[12,15] Lower Potomac Sewage Treat. Plt. Lorton, Va.	Aug. 5, 1971	13,620	3.0	40.82	31.5	270.0	12.25	70	0.90
4	Monterey Water[12,16] Poll. Cont. Plant Monterey, Ca.	Oct. 13, 1971	7,264	8.6	62.5	95.1	79.0	10.82	83	1.49
5	Northwest Bergen[12,17] County Waldwick, N.J.	Jan. 11, 1972	11,986	10.0	119.7	338.5	76.3	37.21	68	3.08
5	Northwest Bergen County Waldwick, N.J.	Nov. 1973	8,535	5.7	48.7	113.9	85.2	13.85	72	1.65
7	Washington Suburban Sanitary Sewer Comm., Piscataway, Md.	Feb. 1974			Results not available					

Table 6-6 (continued). MERCURY EMISSIONS FROM SEWAGE SLUDGE INCINERATION

NOTES:

a. Information was obtained from reports on file at EPA about the source tests at the above locations, and from EPA internal communications: McCarthy, J.A., to Durham, J.F., May 18, 1972, titled "Summary of Sewage Sludge Incinerator NSPS Development," and Salotto, B.V., to Ward, T.E., October 11, 1973, titled "Mercury Analysis of Municipal Sludges."

b. Tests 1 through 5 were performed prior to promulgation of Method 101. They were not isokinetic, were not traversing, employed midget impingers, and are not representative of particulate mercury that probably was present. Method 101 was used in tests 6 and 7.

c. The data on this test would indicate that more mercury (436.4 percent) was emitted from the stack than was introduced into the incinerator by the sludge. In view of the other data, this would appear highly unlikely. Therefore, it is concluded that the emission data from this site are invalid.

parameters and the mercury removal efficiency of a scrubber. The results of all tests suggest that a significant quantity of mercury is collected by water scrubbers.

Mercury removal efficiencies in Table 6-6 are calculated by the following equation:

$$P_{Hg} \text{ removal} = 100 \left(1 - \frac{E_{Hg}}{I_{Hg}}\right) \qquad (2)$$

where $R_{Hg \text{ removal}}$ = removal efficiency, %

E_{Hg} = mercury stack emissions, grams/day

I_{Hg} = mercury input with the sludge, grams/day

The stack test method used in the first five tests in 1971 and 1972 was designed to measure gaseous mercury emissions; stack traversing and isokinetic sampling were not performed. Emissions measured in these tests are therefore not necessarily representative of the mercury in the stack emissions since particulate mercury may not have been representatively sampled. The sixth and seventh tests were performed using Method 101 published in Appendix 2 of the mercury standard (38 FR 8820); this method is designed to accurately account for both gaseous mercury and mercury particulate matter. The average mercury emission factor measured in the first five tests (excluding the Barstow plant) was 1.65 grams of mercury emitted per metric ton of dry sludge incinerated, and the emission factor measured in the sixth test was also 1.65 grams of mercury emitted per metric ton of dry sludge. Results from the seventh test are not yet available. The similar results obtained by both methods indicate that the mercury emitted in a sludge incinerator stack gas that has passed through a wet scrubber is in the vapor form.

Appendix C describes the method of determining atmospheric dispersion estimates and maximum allowable mercury emission levels. Table C-1 describes the source characteristics of a meteorologically restrictive hypothetical sewage sludge incinerator facility, and Figure C-1 describes the maximum allowable emissions. Pasquill Class D stability applies to mercury emissions from sewage sludge incinerators since most incinerators are located away from the centers of cities at suburban and even more remote locations so that tall buildings that cause air disturbances are not expected in the vicinity of such sites. The diffusion model assumes a single emission point and a relatively low effective stack height of 20 meters. The referenced restrictive assumptions in Appendix C were used in order to be reasonably confident that the calculated maximum emission rate would not exceed the ambient concentration guideline of 1.0 $\mu g/m^3$ for a 30-day average under realistic circumstances. Under these conditions, therefore, the maximum allowable emission of mercury from a sludge incineration or drying site is 3200 grams of mercury per 24-hour period.

One of the assumptions used in deriving the maximum allowable mercury emissions from mercury cell chlor-alkali plants and mercury extraction plants differs from those discussed above.[11] An effective stack heigh of 10 meters, which implies essentially ground-level emissions, was used because: (1) chlor-alkali plants discharge some emissions directly from building vents, frequently resulting in aerodynamic downwash, and (2) many mercury extraction plants are located in mountainous areas where the relatively short stacks used result in impingement on the mountains. The decreased stack height results in a lower emission limit of 2300 grams per 24-hour period for these sources.

The solid line in Figure 6-1 is a curve showing the total daily mercury content of sewage sludge for incineration (incinerator input) for Pasquill D stability, assuming no control of mercury emissions, which will result in a mercury concentration of 1 $\mu g/m^3$ in the ambient air. The curve represented by the solid line is the locus of the equation:

$$(C_{Hg})\ \text{Allowable Mercury Input} = \frac{3200\ \text{g/day (allowable mercury emissions)}}{1-\ \text{(mercury removal efficiency)}} \qquad (3)$$

Available data indicate that various degrees of mercury emission control are achieved but that the control efficiency of water scrubbers is not predictable and may be low in some cases. If the level of control of mercury emissions can be established, then a new curve of total mercury content of sewage sludge can be constructed according to equation (3) above, as shown by the curve in Figure 6-2 for 50 percent control of mercury emissions. Total daily mercury incinerator input for all known incineration sites with present maximum potential burning capacities greater than 149,820 kg/day (ca. 330,000 lb/day) of dry solids are plotted in Figures 6-1 and 6-2. Other selected daily mercury inputs are also plotted.

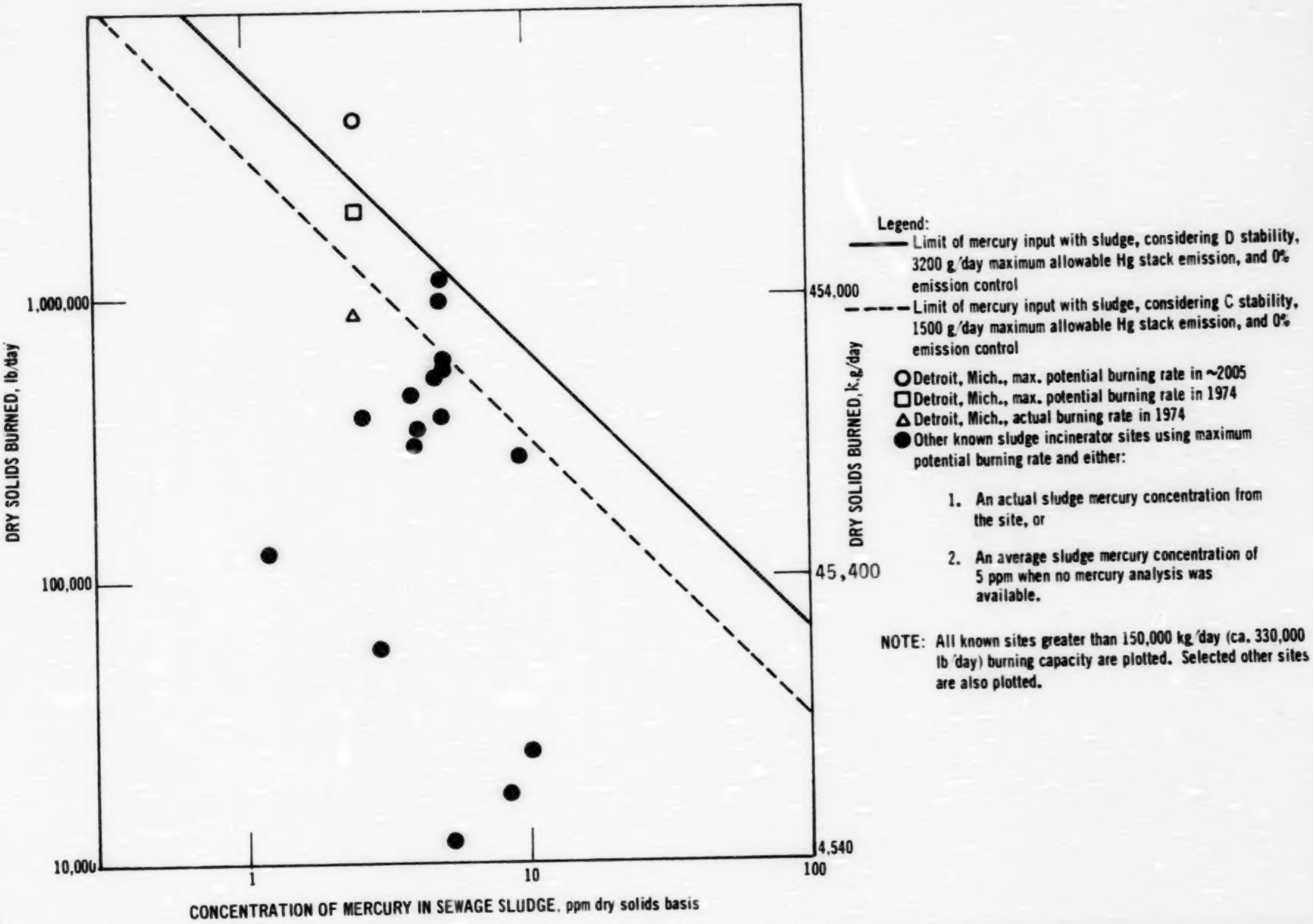

Figure 6-1. Total mercury content of sewage [illegible]

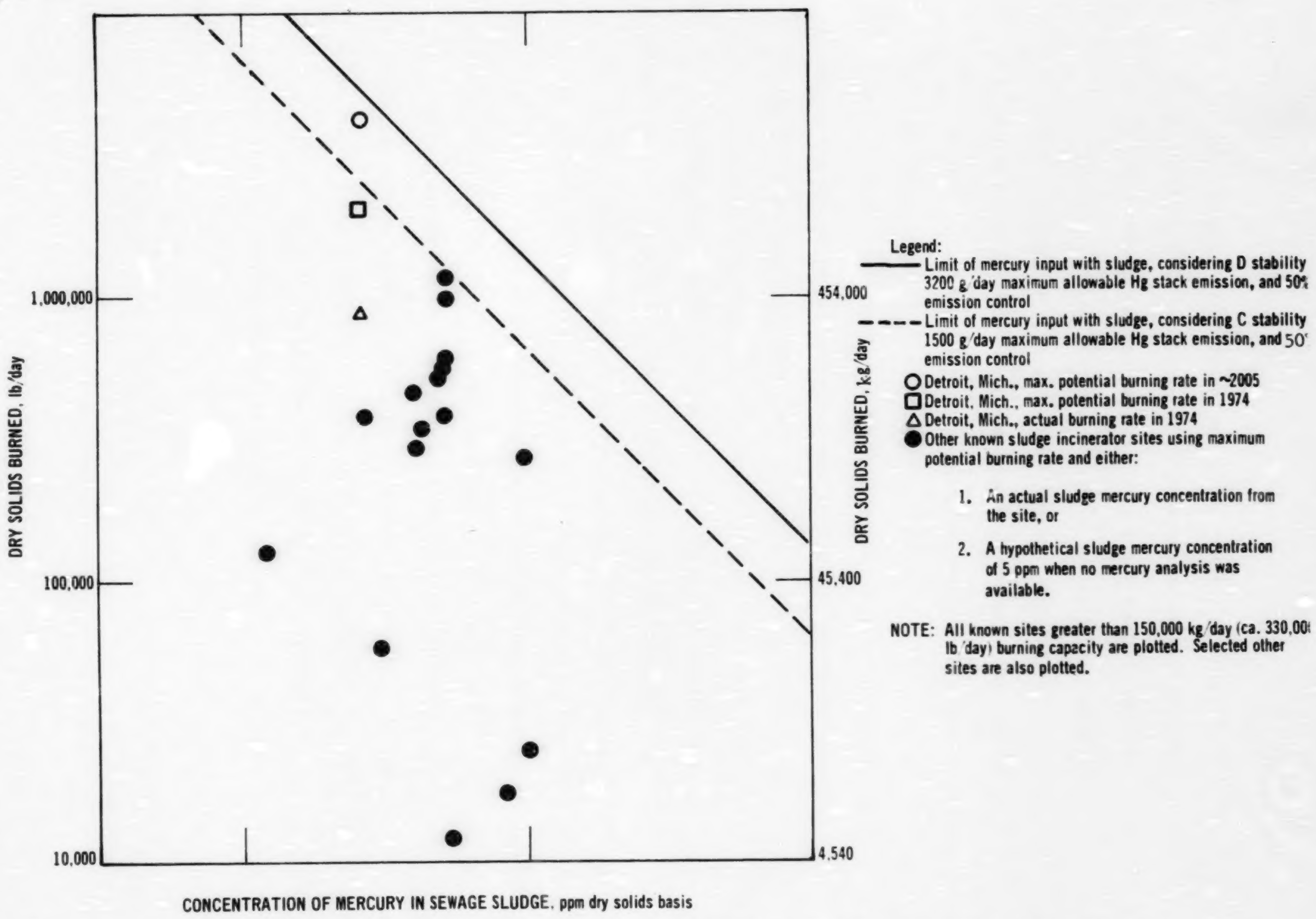

Figure 6-2. Total mercury content of sewage sludge for incineration, assuming 50 percent control of emissions.

No presently known sludge incineration site has a total daily mercury incinerator input in excess of 3200 grams per day. The highest known input is 1000 grams per day at the Detroit, Michigan, incineration site. The Detroit value is based on a sludge incineration rate of 408,600 kg (ca. 900,000 lb) of dry solids burned per day and on a mercury concentration of 2.5 ppm Hg, dry solids basis, which is the average of two sludge analyses in December 1973. If mercury concentrations of sludge corresponding to the upper limit of the range of mercury content as shown in Table 6-2 occurred at the maximum burning capacities shown in Table 6-4, the total daily mercury content of the sludge produced would far exceed 3200 grams. The largest sludge incineration facility that is contemplated for the near future would incinerate 908,000 kg (ca. 2,000,000 lb) of dry solids per day; if sludge with the highest reasonably expected mercury content of 15 ppm were incinerated, and if 50 percent of the mercury in the sludge were emitted into the atmosphere, the plant would emit 6,800 grams of mercury per day.

The production of sewage sludge in excess of 1,362,000 kg/day (ca. 3,000,000 lb/day) of dry solids is approaching reality in New York City; other smaller municipalities could produce amounts well in excess of 681,000 kg/day (ca. 1,500,000 lb/day) of dry solids.

Although our investigations were mainly focused on the incineration of municipal sewage sludge, it became apparent during the investigation that the incineration of wastewater treatment plant sludges and pretreatment sludges from various industries could present the same problems as the incineration of municipal sludges. Information obtained from the City of Chicago indicates that approximately 40 percent[10] of the mercury content of sewage sludge can be emitted during the drying operation. For this reason, the proposed standard is made applicable to the incineration and drying of all wastewater treatment plant sludges. The proposed standard also applies to the incineration and drying of industrial wastewater sludges.

The most direct method for demonstrating compliance with the emission standard is performing an approved stack emission test demonstrating that the actual stack emissions are below the maximum allowable emission level of the regulation. However, the mercury stack emission test (Method 101) can cost in excess of $5,000. If the mercury input into the incinerator or dryer is determined and if it is further assumed that all of the mercury that enters into the incinerator or dryer is emitted to the atmosphere, an effective method of compliance would be to demonstrate that the mercury input into the process is less than the emission standard. An advantage of this method of compliance is that it is relatively inexpensive and would cost less than $200 per compliance test. A plant whose input is measured to be less than the standard is in compliance. An operator of a plant whose input is in excess of the standard has the option of testing mercury emissions by the stack sampling method. In the latter case, any collection efficiency achieved by the control system will be reflected in the results. For a facility in excess of the standard after stack testing, no mercury removal processes for sludge or stack gases are currently available. A plant in this situation would have to reduce mercury emissions by (1) reduction of the burning rate, (2) determination of sewage system users, if any, which put high mercury content sludges into the sewage system, and the requirement that those users pretreat their sludges to remove mercury, and (3) any other acceptable means to achieve reduction of emissions to acceptable levels.

Most affected facilities will probably choose the less expensive sludge sampling compliance option; relatively few, if any, will find it necessary to sample stack emissions.

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7. ENVIRONMENTAL IMPACT

ASBESTOS

The proposed amendments to the asbestos standard will have significant beneficial effects by reducing emissions of asbestos and mercury to the outside air; they may also have limited adverse effects on land and water resources. In the judgment of the Administrator, however, the beneficial effects of the proposed amendments outweigh the following potentially adverse effects that were considered:

1. More asbestos waste will be collected in control devices and will have to be disposed of.
2. The use of dust-suppression agents to prevent wind erosion of asbestos waste may cause water pollution.
3. Other possibly harmful fibers such as fiberglass and mineral wool are substituted for asbestos in friable insulating materials.
4. Alternative disposal methods to the incineration of wastewater treatment plant sludges may cause mercury pollution of land and water.

The proposed amendments will force more efficient cleaning of gases now being emitted to the outside air from some asbestos manufacturing and fabrication plants; this action in turn will result in the production of more asbestos-containing material for disposal.

However, the land disposal of such waste will be regulated by the proposed standard, which will ensure protection against emissions to the outside air during all steps of the disposal process. Further, potential asbestos water pollution problems at disposal sites can be prevented by proper selection, design, and operation of the sites. All landfill sites where asbestos wastes are deposited should be selected so as to prevent horizontal and vertical migration of asbestos fibers to ground or surface waters. In cases where geologic conditions may not reasonably ensure this, adequate precautions, such as the installation of impervious liners for the waste disposal site, should be taken to ensure long-term protection of the environment. Further, the intrusion of moisture into land disposal sites for asbestos should be minimized. To assist in the appropriate future use of asbestos waste disposal sites, the location of such sites should be permanently recorded in the appropriate office of the legal jurisdiction where the site is located. The asbestos waste disposal standard will be beneficial in reducing the amount of asbestos wastes that are disposed of, since it will stimulate some manufacturers who produce large quantities of potential wastes to reuse more of these wastes in their processes. The proposed standard will not increase the total quantity of asbestos waste to be disposed of from demolition and renovation operations, but will result in the segregation of the asbestos waste from large quantities of other demolition and renovation debris. Because the asbestos waste will then be more concentrated, strict control of the disposal operations under the proposed standard will be more economical and manageable.

The use of dust-suppression agents as optional methods to control wind erosion on all portions of asbestos mill tailings piles and on active sections of other asbestos waste disposal sites should reduce the total amount of asbestos entering surface waters from such sites. Such agents have been used successfully to prevent wind erosion of dust from various sources such as dirt roads, mine tailings disposal areas, farm lands, and airports. Although these agents could possibly cause land and water pollution problems, the history of usage over a period of more than 10 years has not revealed any substantial pollution problems. These agents are not toxic in the dilute form in which they are applied. After the agents have cured for a few hours, they will erode away only with long-term weathering.

Although asbestos is no longer used in manufacturing friable insulating materials in the United States, the proposed standard bans the use of asbestos and therefore allows the use of substitute fibers such as ceramic wool, mineral wool, and fiberglass. In contrast with asbestos, there is no evidence that these materials cause adverse health effects in the concentrations found in occupational or ambient environments.

MERCURY

The proposed mercury standard will limit mercury emissions from wastewater treatment plant sludge incinerators and dryers. No known existing incinerator sites are exceeding the standard.

Should an incineration or drying site exceed the maximum allowable emission and have to reduce its capacity, there are three known major alternatives for disposal of sewage sludge: (1) burning at an acceptable separate location or in acceptable separate incineration systems, (2) land disposal, or (3) ocean disposal. Wet oxidation and pyrolysis are other less used alternatives. The first alternative includes burning or drying at additional locations, burning in conjunction with municipal solid waste, or burning in conjunction with coal-fired boilers. Land disposal includes soil improvement by addition of liquid and dry sludge, landfilling of sludges, and composting of sludges with solid wastes. Few new ocean disposal sites for sludges are anticipated.

In summary, no presently known facilities will be affected. The number of potential affected facilities is small, and in those facilities only a fraction of sludge production would have to be disposed of by alternative methods. The relative significance of the quantity of sludge that may have to be disposed of on land as a result of the proposed standard is anticipated to be insignificant compared to the amounts of sludge that are already being disposed of on land. The impact of the standard on air is considered to be positive in every conceivable case. Therefore, the adverse environmental impact of this standard is considered to be minimal.

8. ECONOMIC IMPACT

ASBESTOS

Although the proposed amendments are not based on economic considerations, EPA has evaluated the economic impact and judges it to be reasonable. Costs for compliance among the various sources covered by the amendments are variable. In most cases the economic impact is not based on detailed cost estimates because such information is not available; for example, detailed information concerning the number, size, and characteristics of additional sources covered by the proposed demolition and renovation regulation is not available. Although the amendments may adversely affect some marginal plants or companies, the impact to the asbestos industries as a whole should not be large. A summary of the economic impact is given in Table 8-1.

Asbestos Manufacturing

Only one known shotgun shell manufacturing plant in the United States uses asbestos. This plant already has mechanical particulate collectors and spray scrubbers which reduce the asbestos emissions; however, it may be necessary for the plant to install the fabric filtration devices specified by the regulation. Such additions would include two 28-am^3/min (ca. 1000-acfm)* baghouses at an installed cost of approximately $8400. The annual operating cost would be approximately $2100, which amounts to about 1.5 cents per 100 boxes of shells or about 0.005 percent of the product value. The plant is expected to be able to manage this increased cost if additional controls are necessary to comply with the proposed regulation.

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*am^3/min = actual cubic meters per minute;
acfm = actual cubic feet per minute.

Table 8-1. SUMMARY OF ECONOMIC IMPACT OF PROPOSED AMENDMENTS TO ASBESTOS STANDARD

Industry	Number of Potential Sources	Estimated No. of Sources That Must Add Additional Controls	Estimated Maximum Cost to Industr to Comply with Proposed Amendment	
			Capital ($)	Annual ($)
1. Manufacturing				
A. Shotgun Shell	1	1	8,400	2,100
B. Asbestos Asphalt Plants	5000 (50/year)	10/year	42,000	11,000
2. Fabrication				
A. Asbestos Building Products	12	0	0	0
B. Asbestos Friction Products				
(i) Large	20	0	0	0
(ii) Intermediate & Small	380	100	420,000	110,000
C. Asbestos Board Fabricators	100	20	84,000	21,000
3. Demolition	300	300		520,000
4. Renovation	No estimate	1000		500,000
5. Disposal of Wastes				
A. Mills	6	3	75,000	24,000
B. Manufacturing & Fabrication	1250	625		1,250,000
C. Demolition	3300	3300		1,650,000
D. Spraying	No estimate	0	0	0
6. Waste Disposal Sites				
A. Mills (In Use	6	6	48,000	150,000
(Closed)	6	6	48,000	0
B. Industry Operated Disposal Sites	15	10	95,000	50,000
C. Private & Municipal				
(i) Covered	1200-2000	500 (Sanitary landfill)	400,000	600,000

The asphalt concrete industry consumes approximately 4500 tons of asbestos per year and the total amount of asbestos-asphalt concrete produced nationwide is estimated to be 136,200 metric tons (ca. 150,000 tons) per year. This amount of asbestos-asphalt concrete represents less than 0.1 percent of the total amount of asphalt concrete produced in the United States, and involves approximately 50 plants annually of the estimated 5000 asphalt concrete plants in the United States. Even for these plants, asbestos-asphalt concrete represents less than 10 percent of the total amount of asphalt concrete produced.

EPA estimates that approximately 10 percent (500) of the existing plants can already comply with the proposed regulation; no additional expense would be required if such plants chose to manufacture asbestos-asphalt concrete. The existing asphalt concrete plants that cannot comply with the proposed amendment (approximately 4500 plants) will have to install additional controls if they desire to manufacture asbestos-asphalt concrete. Such plants will probably install a small control device to treat only the asbestos-contaminated gas streams, rather than a control device for all emission streams from the facility. For an average-sized plant, the maximum amount of ventilation air flow attributable to the mixer and the ventilation system for asbestos materials handling would be approximately 28 am^3/min. The installed capital cost of a baghouse of this size would be \$4200 and the annual operating cost would be \$1100. The capital cost of the small baghouse represents approximately 1.5 percent of the total capital invested in an average-sized plant. The annual cost amounts to 0.5 percent of the value of the asbestos-asphalt concrete produced.
If as many as 10 asbestos-asphalt concrete plants per year installed

such a baghouse, the capital investment for the entire industry would be $42,000, and the annual operating cost would be $11,000. The additional control required by the provisions of the proposed amendment will be taken into consideration in the calculated profitability of manufacturing asbestos-asphalt concrete by each plant operator on a case-by-case basis. If the venture is profitable, the operator will add the appropriate control device and manufacture asbestos-asphalt concrete. If it is not, the operator will not use asbestos and will still manufacture asbestos-free asphalt concrete.

The Agency estimates that some 80 to 90 percent of the new and modified asphalt concrete plants will install fabric filter collection devices, and the remainder will install venturi scrubbers to comply with the Federal new source performance standard for particulates (40 CFR Part 60). New fabric filter collection devices can meet the requirements specified under 40 CFR 61.23(a). Most of the scrubbers installed on new and modified plants are also expected to be able to comply with the no-visible-emission requirement of the proposed amendment. The economic impact of the proposed amendment for new and modified plants is therefore expected to be minimal.

Asbestos Fabrication

The Agency's investigation of the asbestos fabrication industry, which included inspections of fabrication sites and air pollution control equipment, and consultations with industrial representatives and trade associations, was used as a basis for the estimates presented in this section.

All of the 12 estimated fabricating facilities for asbestos building products are estimated to be able to meet the proposed amendments with existing control equipment. Therefore, the proposed amendments are expected to have no impact on these sources.

An estimated 20 large facilities fabricate asbestos friction products and most of these already comply with the proposed amendments. Approximately 100 of an estimated 380 friction product fabricators of intermediate and small size will have to add controls. Most of these sources will require control devices no larger than 28 am^3/min in capacity. If a baghouse of this size is chosen, the installed capital cost would be $420,000 for the entire asbestos friction product fabrication industry and the annual operating cost would be $110,000.

Approximately 20 of the estimated 100 asbestos-cement or asbestos-silicate board fabrication facilities subject to the proposed amendments will be required to add or upgrade control equipment. If one 28-am^3/min fabric filtration device is added at each facility, the estimated installed capital cost for the industry would be $84,000 and the annual operating cost would be $21,000.

Asbestos Demolition and Renovation

The general economic impact of the demolition regulation, discussed in the background information document for the promulgated standard,[1] is incrementally increased by the proposed amendments to the standard. The only proposed amendments that are expected to have a significant economic impact are the renovation provisions and the extension of demolition coverage to apparatus other than pipes, boilers, and load-supporting structural members (i.e., to tanks, reactors, turbines, furnaces, and non-load-supporting structural members).

The stripping of friable asbestos materials from tanks, reactors, turbines, furnaces and non-load-supporting structural members, or the removal of such apparatus from buildings with the asbestos materials intact, will increase the number of sources subject to the demolition standard by an estimated 10 percent. Although the demolition standard was estimated to increase demolition costs by $45 million annually (based on the demolition of 26,000 buildings per year),[1] experience in enforcing the standard since promulgation indicates that the actual number of demolition operations and the additional cost imposed by the demolition standard is much less than previously predicted. Based on the number of demolition operations reported to one Agency Regional Office in the period since promulgation and adjusting this value to reflect additional demolition operations covered by the promulgated standard that were unreported, it is estimated that the number of demolition operations performed in the United States and covered by the standard is less than 3000 per year. The estimated cost of complying with the demolition provisions is therefore only $5.2 million per year instead of the $45 million that was previously estimated. The impact of the additional coverage of the proposed amendments to the demolition standard is estimated to be 10 percent of the total impact of the demolition standard or an annual operating cost of $520,000.

The number of renovation operations subject to the proposed amendment is large, but will probably be less than the number of building demolitions. The additional cost required to comply with the proposed regulation will be the cost of stripping friable asbestos materials from pipes and other specified apparatus. The amendment will apply only to relatively large residential and non-residential building renovation operations (for example, where heating systems are removed) since only operations involving the removal of more than 80 meters of pipe or more than 15 square meters of boiler, tank, reactor, turbine, furnace, or structural member insulation are covered. The rebuilding of industrial plants will in most cases involve the removal of pipes and apparatus in sufficient quantities to be subject to the proposed amendment. The replacement of apparatus in non-residential buildings and chemical plants will also be covered by the proposed amendment in certain cases. For a relatively small-scale renovation involving removal of pipes and apparatus, the total renovation cost will be about $50,000. The additional cost required to comply with the proposed amendment for such a renovation operation would be the cost of labor for wetting and stripping the friable asbestos materials from the pipes and apparatus during this operation. The stripping cost for such an operation is estimated to be $250.

The cost required by the proposed amendment for stripping and wetting should thus be no more than 0.5 percent of the cost of the renovation operation. If 1,000 renovations per year are subject to the proposed standard and the average total cost for each renovation is $100,000, the total industry annual operating cost to comply with the proposed standard is estimated to be $500,000.

Within a broad range of costs, the demand for demolition or renovation services is inelastic because of the lack of feasible alternatives. Even if old buildings and structures are abandoned, local government agencies will eventually be forced to have them demolished. Because the demand for these services is inelastic, the increased cost of demolition or renovation will be borne by the consumers of these services, rather than by the contractors, and any additional renovation or demolition costs will be passed on.

Disposal of Asbestos Wastes

Several asbestos mills will have to adopt control methods for the tailings disposal process to comply with the proposed amendments. The installed capital cost of a screw mixer and associated equipment for wetting tailings prior to dumping is estimated to be approximately $25,000 per mill and the annual operating cost is estimated to be $8000. Six asbestos mills are currently operating. One mill uses a wet milling process and therefore produces wet tailings, and two other mills have already installed screw mixers and wetting systems. For the three operating asbestos mills that may have to add screw mixers, the total capital investment cost to the industry is estimated to be $75,000 and the total annual operating cost is estimated to be $24,000.

A substantial number of asbestos manufacturing and fabricating operations already comply with the proposed amendments and will therefore incur no additional expenditure. It is estimated that 50 percent of these sources may already comply with the asbestos waste disposal standard. The proposed amendments will increase the trend of recycling wastes at manufacturing operations and thus will not increase the amount of asbestos waste that must be disposed of. However, some manufacturing and fabrication operations will incur increased costs for wetting, packaging, and labeling the waste. The average additional cost imposed by the proposed amendments is estimated to be approximately $2000 annually per source. This estimate does not include additional costs for collection, transportation, or deposition on a disposal site, since these operations are currently being performed. For a few large manufacturing sources, the additional annual cost may be significantly higher than $2000, but for many other sources the additional waste disposal cost would be less. Approximately 500 fabrication sources and 750 manufacturing sources will be subject to the proposed amendments, and 50 percent (625) are estimated to already be in compliance. The total additional cost imposed on this industry by the proposed amendments is estimated to be $1.25 million per year.

The amount of friable asbestos material that must be disposed of to comply with the proposed amendments will be relatively small for most demolition and renovation operations. While pipes and other specified items covered with friable asbestos material may be disposed of intact, the salvage value of the metal will probably provide sufficient incentive to strip the insulation from such items. The additional cost incurred in disposing of the stripped friable asbestos wastes is expected to be no more than $500 per demolition or renovation source, even for large renovation and demolition operations. This figure includes the cost of consolidating the stripped materials, wetting the waste material, packaging the material in impermeable containers, and labeling the containers. The annual cost of complying with the proposed waste disposal standard is estimated to be $1,650,000. Other waste disposal disposal costs such as transportation and deposition in a waste disposal site are incurred even in the absence of the proposed amendments and cannot logically be assessed as an additional cost imposed by the proposed amendments. As previously explained, any additional cost for disposal of renovation and demolition waste will probably be borne by the owner of the building being demolished or renovated.

Since it appears that asbestos waste from spraying operations is now being disposed of in accordance with the proposed waste disposal amendments, it is expected that there will be no economic impact on this source category.

Waste Disposal Sites

Asbestos wastes generated by sources subject to the proposed amendments are deposited on large asbestos mill tailings piles usually operated by the mill, waste disposal sites owned by asbestos companies, and private and municipal solid waste disposal sites. The proposed amendments require that there be no visible emissions from the disposal sites, or optionally that the owners or operators of the site comply with certain specified procedures. In addition, the proposed amendments require the posting of warning signs and the fencing of specified waste disposal operations.

An estimated six asbestos mill tailings piles are in current usage, and six are completely inactive. The Agency's investigation indicated that completely inactive sites will probably be in compliance with the no-visible-emission provision of the proposed amendments. Warning signs and fencing must be installed where not already in place. Assuming that the average-sized, completely inactive tailings pile covers 200,000 m^2 (ca. 50 acres), the cost of installing fencing and warning signs is estimated to be $8000 per site, or $48,000 for the six existing inactive tailings disposal sites.

One, and perhaps two, of the six asbestos mill tailings piles in current usage will probably be able to comply with the proposed no-visible-emission provision without additional expenditures. The average size of such tailings disposal sites is approximately 200,000 m^2 (ca. 50 acres). The majority of this area is inactive, with the recent working face and vehicle roads on the tailings pile the only active portions. The Agency's observations during inspections of tailings piles indicated that many of the inactive portions of disposal piles are unlikely to discharge visible emissions, and therefore expenditures for dust-suppression agents or other control measures would not be required to comply with the proposed amendments. Where controls are needed on the inactive portions of a disposal site, a dust-suppression agent will probably be applied. The annual expenditure for application to a tailings disposal area would be $15,000.

Since most asbestos mills will use the method of wetting tailings with a dust-suppression agent to comply with the proposed tailings disposal provision, the active face of the disposal site will probably meet the no-visible-emission provision without additional expenditures. If dust-suppression agents must be applied to the active portions of a disposal site, the annual operating cost is estimated to be approximately $10,000. In some cases fencing may already be installed, thus not requiring additional expenditures. The capital costs for fencing and warning signs are estimated to be approximately $8000 for a 200,000 m^2 disposal site. While the actual expenditures to be made by currently used tailings disposal sites as a result of the proposed amendments are not known, a worst case would require an annual operating cost of $25,000 for dust-suppression agent application and also a capital cost of $8000 for fencing and warning signs. On an industry-wide basis, six tailings disposal operations would have to spend $150,000 in annual operating costs for applying dust-suppression agents and $48,000 in capital costs for installing fencing and signs.

An estimated 10 to 15 asbestos waste disposal sites are operated by asbestos manufacturing and fabrication sources. Several of these disposal sites will probably require additional control methods to comply with the no-visible-emission provisions of the proposed amendments. The optional compliance method requires that inactive sections be covered with 60 cm (centimeters) of non-asbestos-containing material, or with 15 cm of non-asbestos-containing material and a vegetative cover. The average area of such sites is estimated to be 12,140 m^2 (ca. 3 acres). The most costly method of compliance would be to cover the entire inactive section of the disposal site with 60 cm of soil, which would cost approximately

$20,000. The establishment of a vegetative cover, including 15 cm of covering soil, initial cultivating, seeding, and fertilization, is estimated to cost $7000 for a 12,140-$m^2$ site; the annual vegetative maintenance would cost an estimated $1000 per year for a 12,140-m^2 (ca. 3 acres) site.

The optional compliance method for active sections requires that either a dust-suppression agent or a 15-cm cover of non-asbestos material be applied at the end of each operating day. The estimated annual operating cost for applying a dust-suppression agent at the end of each operating day is $4000. The cost required to put on 15 cm of cover at the end of each operating day will probably be more than the cost of applying a dust-suppression agent but will not require the installation of a fence when used in conjunction with an optional method for inactive sections of a disposal site. The capital cost for fencing, where required, and warning sign installation is estimated to be $2500 per site.

For a disposal site to comply with the standard, the capital investment cost would be $9500 and operating costs would be $5000 per year. The choice of a 60-cm cover rather than the less costly option of a vegetative cover would require a capital investment of $22,500 and an annual operating cost of $5000. Only a few of the disposal sites will have to expend such sums of money to comply with the proposed standard. However, capital cost would be $95,000 and annual operating cost would be $50,000 if as many as 10 disposal sites had to adopt the optional control methods of the proposed standard.

Many states have recently instituted permit systems for solid waste disposal sites, and the operating status of many sites is in a state of change. The current and future trend is to the operation of such sites as sanitary landfill operations. While the proposed standard for asbestos waste disposal sites could require changes in operating practices at a large number of private and municipally operated waste disposal sites, these changes are consistent with the trend to operate as sanitary landfills. The total number of private and municipally operated waste disposal sites is not known, though various estimates have been made. Based on a 1968 estimate that was updated in 1971 by the Agency, 1500 landfill sites in the United States use some type of cover and 14,000 disposal sites do not use cover. The Agency has recently made another estimate based on a survey of four states, with results prorated on the basis of population to the entire United States. This estimate indicates that there are 6000 disposal sites that do not meet the criteria of a sanitary landfill site and 2000 sanitary landfill sites.

If a site that accepts asbestos-containing waste meets the criteria for a sanitary landfill, it will comply with the provisions of the proposed amendments except for the installation of warning signs. The capital cost for installing signs around a landfill site coveri 161,880 m^2 (ca. 40 acres) is estimated to be $500. Disposal sites that are not sanitary landfills but which accept asbestos wastes will probably upgrade a section of the site to meet Federal sanitary landfill guidelines and will have to add warning signs. The amount of asbestos-containing waste deposited at a landfill will be rather small, in most cases, compared to the amounts of other solid wastes that are landfilled. It is estimated that less than 1.8 metric tons/day of asbestos-containing waste will be deposited at an average site. Based on an estimated sanitary landfill operating cost of $3.30/metric ton,[2] the annual operating cost for sanitary landfilling only asbestos-containing waste would be approximately $2000. It is estimated that 500 sanitary landfills and 300 open disposal sites will dispose of asbestos-containing waste. The estimated total additional cost incurred on waste disposal site operations by the proposed standard is estimated to be capital costs of $400,000 for signs and fencing and an annual operating cost of $600,000. The increased cost of disposing of asbestos-containing waste would probably be passed on to the waste generator, and the economic impact of the proposed amendment on the operators of disposal sites would therefore be minimal.

MERCURY

The proposed standard for mercury emissions from sewage sludge incineration and drying plants is based on maintaining the ambient air guideline deemed safe by the Administrator as required by section 112 of the Act and does not require that economics be considered. The economic effect will, however, be minimal for the following reasons: (1) no known affected facilities will be required to make sludge handling adjustments; (2) even in the few situations which conceivably could require the alternative disposal of sludges, only a fraction of the sludge production would be affected; and (3) for future plants or expansion of existing plants, the emission limit will allow relatively large incineration plants to be operated. If the sludge mercury concentration is 5.0 ppm dry solids basis and the collection efficiency is 50 percent, these large installations can incinerate or dry up to 1,225,800 kg (ca. 2,700,000 pounds) of dry solids per day. The actual allowable burning rate with respect to mercury will depend ultimately on the actual sludge mercury concentration and removal efficiencies.

The cost impact of sludge mercury analysis is considered to be relatively small (approximately $200 per compliance test), and some treatment plants already routinely perform mercury sludge analysis. The cost of a compliance stack test using Method 101 can exceed $5000 and will be significant for small facilities. Most facilities, however, will be able to use the less expensive sludge sampling option to determine compliance.

REFERENCES

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2. Decision-Makers Guide in Solid Waste Management, U. S. Environmental Protection Agency, Office of Solid Waste Management Programs, no date.

APPENDIX A. OPTIONAL AIR-CLEANING METHODS FOR COMPLIANCE WITH ASBESTOS STANDARD

As an alternative to meeting the no-visible-emission requirement of the proposed amendment to the asbestos standard, a source owner or operator may fulfill the following requirements:*

(a) Fabric filter collection devices must be used, except as noted in paragraphs (b) and (c) of this section. Such devices must be operated at a pressure drop of no more than 10 cm (ca. 4 inches) water gauge, as measured across the filter fabric. The airflow permeability, as determined by ASTM method D737-69, must not exceed 30 $ft^3/min/ft^2$ for woven fabrics or 35 $ft^3/min/ft^2$ for felted fabrics, except that 40 $ft^3/min/ft^2$ for woven and 45 $ft^3/min/ft^2$ for felted fabrics is allowed for filtering air from asbestos ore dryers. Each square meter of felted fabric must weigh at least 475 grams (ca. 14 ounces per square yard) and be at least 1.6 mm (ca. one-sixteenth inch) thick throughout. Synthetic fabrics must not contain fill yarn other than that which is spun.

(b) If the use of fabric filters creates a fire or explosion hazard, the Administrator may authorize the use of wet collectors designed to operate with a unit contacting energy of at least 102 cm (ca. 40 inches) water gauge pressure.

(c) The Administrator may authorize the use of filtering equipment other than that described in paragraphs (a) and (b) of this section if the owner or operator demonstrates to the satisfaction of the Administrator that the filtering of particulate asbestos material is equivalent to that of the described equipment.

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*These requirements are quoted from §61.23 of the standards promulgated April 6, 1973 (38 FR 8820).

(d) All air-cleaning equipment authorized by this section must be properly installed, used, operated, and maintained. Bypass devices may be used only during upset or emergency conditions and then only for so long as it takes to shut down the operation generating the particulate asbestos material.

APPENDIX B. CHEMICAL STABILIZATION OF WASTE DISPOSAL SITES

More than 1 billion tons of mineral-processing waste are produced annually in the United States. Approximately 40 percent of this is fine-sized material, and stabilization measures must be taken to prevent air and water pollution problems from arising.[1] The initial step is the planning of waste disposal operations to ensure that the wastes are not haphazardly deposited in piles with dangerously steep banks, which could increase runoff or windblown emission problems. Although establishing a vegetation cover might be the preferred stabilization method for aesthetic considerations, it is often not practical because of the high cost. As a recourse, a vegetative-chemical or chemical method of stabilization must be considered.

Chemical stabilization of waste piles involves the reaction of a reagent with the waste to form a crust or layer resistant to air and water erosion. There is a wide variety of dust-suppression agents with different base materials. The majority of the reagents have a bituminous, resinous adhesive, or elastomeric polymer base. Although chemical stabilizers are not as durable as vegetation, they are more versatile. For example, chemicals can be used in very dry regions, where there is not enough moisture to support appropriate vegetative growth. The application method is usually determined by the size and topography of the pile. The most common application methods are spraying the waste pile with either a tank truck or an airplane. It may be possible to employ different spraying techniques at smaller waste disposal sites. For instance, hand sprayers or trucks equipped with a high-pressure hose can be used to apply the chemical agent.

Chemical stabilizers, or dust-suppression agents, have been used successfully to control windblown emissions in a wide variety of applications. At a uranium tailings pile in Arizona, vegetative procedures were investigated and determined to be unsuitable because of the extremely low annual precipitation.[1] The use of a soil or rock covering was considered to be too expensive. In May 1968, U.S. Bureau of Mines personnel applied dust-suppression agents to two portions of the uranium tailings pile. The chemicals were applied with a self-propelled, lightweight sprinkling device because only a few acres were stabilized. The sprinkling device is mounted on two wheels and as the spraying arm rotates to distribute the chemicals, the device moves along a predetermined route. The treated sections of the disposal pile were inspected each year, and in 1972 the inspection indicated that approximately 40 percent of the dike area that had been stabilized with an elastomeric polymer showed disruption of the surface layer. The primary reason for the disruption was determined to be physical disturbance rather than weathering of the stabilizing agent. Although this test may reflect an extended durability of the agent due to the lack of appreciable rainfall, it does indicate that chemical stabilizers are effective in reducing windblown emissions from tailings piles. The second stabilizing agent used was calcium lignosulfonate, which was applied to the pond area. The 1972 inspection showed that the crust was still intact and unbroken.

Another example of chemical stabilization is the control of emissions from a copper mill tailings pond.[2] An emulsion of petroleum and water was sprayed on the pond at a rate of 2.7 liters per square meter (ca. 0.6 gallon per square yard). This treatment demonstrated effective dust control in winds up to 27 mps (ca. 60 mph). The installed cost at this particular facility was approximately $0.044 per square meter (ca. $178 per acre). Other techniques that were tested and proved unsatisfactory for this application were water sprays, snow fences, and plowing of the site.

Chemical stabilizers have reportedly been used successfully to control dust emissions in many other situations. Amusement parks, airfields, construction areas, playgrounds, roads, and schools are just a few of the other applications. Effective application rates have been determined for many of the promising agents,[2] and U.S. Bureau of Mines personnel have been involved in most of these tests. By performing rate screening tests, various application rates can be studied. Chemical stabilizers are applied to samples at different application rates. Each sample can then be tested under controlled wind velocities and the amount of wind erosion loss can be measured. Durability of the chemical stabilizer can be tested by exposing samples to various weather factors and measuring the amount of sample lost by wind erosion.[3] The percent of sample lost can be used to indicate the effectiveness and life expectancy of the chemical stabilizer. The installed cost of dust-suppression agents varies from approximately \$0.016 per square meter to \$0.235 per square meter (ca. \$65 per acre to \$950 per acre).

The effectiveness of dust-suppressing agents is governed by a number of factors, for example, the homogeneity, permeability, reactivity, pH, and salt content of the surface. These parameters frequently exhibit a wide range of variation over the surface of a waste disposal pile. Each type of waste should be tested by the manufacturer of the dust-suppressing agent so that these factors are considered in determining the application rates. Some waste disposal piles may have steep slopes and special techniques such as high pressure spraying or airplane and helicopter application may have to be employed. Chemical stabilization can remain effective for a period of several years provided: (1) the site is properly prepared by considering the previously mentioned factors, (2) prior compacting or grading is performed where necessary, and (3) annual maintenance is performed.

Two manufacturers of dust-suppression agents were contacted by the Agency[4,5] to obtain information on whether the agents would cause water pollution problems. Although no tests have been performed on runoff water from chemically stabilized waste piles, the toxicity of several chemical stabilizers has been determined. The products of the two manufacturers contacted had been shown to have a very low level of toxicity. Both manufacturers stated that after the agent has cured in place, the agent's adhesive bond to the soil particles is very strong as evidenced by the durability and long life of the products. Ample time should be allowed for a chemical stabilizer to cure before rainfall to avoid dissolving the agent in water runoff. No concrete evidence is available to show that dust-suppression agents do not create a water pollution problem, but the lack of reported complaints and problems concerning the reagents over a period of approximately 10 years of use indicates that they do not cause significant land or water pollution problems. If the agent should get into a river or stream, the low erosion rate of the material indicates that it would be so dilute that it would be very unlikely to cause problems.

Additional sources of published information on chemical stabilization are listed at the conclusion to this Appendix.

REFERENCES

1. Dean, Karl Clyde, et al., Methods and Costs for Stabilizing Fine-Sized Mineral Wastes, U.S. Bureau of Mines, Washington, D.C., 1974.

2. Dean, Karl C. and Richard Havens, Stabilizing Mineral Wastes, U.S. Bureau of Mines, Washington, D.C., 1971.

3. Armburst, D.V., and J.S. Dickerson, "Temporary Wind Erosion Control: Cost and Effectiveness of 34 Commercial Materials," J. Soil and Water Cons. 26(4): 154-156, 1971.

4. Canessa, William (Manager, Products Engineering, Witco Chemical Corporation), letters to Archie Lee (EPA), July 1 and September 6, 1974.

5. Parks, C.F. (Dowell Division of the Dow Chemical Company), letter to Archie Lee (EPA), September 13, 1974, enclosing "An Evaluation of Stabilization of Active Tailing Ponds with Water-Swellable Polymers," prepared for the Environmental Quality Conference for the Extractive Industries of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., Washington, D.C., June 7-9, 1971.

ADDITIONAL SOURCES OF INFORMATION

Dean, Karl C., Richard Havens, and Kimball T. Harper, Chemical and Vegetative Stabilization of a Nevada Copper Porphyry Mill Tailing, Bureau of Mines RI 7261, Washington, D.C., May 1969.

Havens, Richard, and Karl C. Dean, Chemical Stabilization of the Uranium Tailings at Tuba City, Arizona, Bureau of Mines RI 7288, Washington, D.C., August 1969.

James, A.L., "Stabilizing Mine Dumps with Vegetation," Endeavor (London), 25(96): 154-157, 1966.

Chepil, W.S., et al., "Vegetative and Nonvegetative Materials To Control Wind and Water Erosion," Soil Sci. Soc. Am. Proc. 27: 86-89, 1963.

Lyles, Leon, et al., "Spray-on Adhesives for Temporary Wind Erosion Control," J. Soil and Water Cons. 25(5): 190-193, 1969.

Investigation of Fugitive Dust, Volume I, Sources, Emissions, and Control, Publication No. EPA-450/3-74-036-a, Environmental Protection Agency, Office of Air and Waste Management, Research Triangle Park, N. Carolina, June 1974.

APPENDIX C. ESTIMATION OF ALLOWABLE MERCURY EMISSIONS FROM SEWAGE SLUDGE INCINERATION FACILITIES

A hypothetical sewage sludge incineration facility was modeled to estimate maximum allowable 30-day average mercury emissions. The basic restriction on emissions is that the ambient 30-day ground-level concentration of mercury (1.0 μg/m^3) must not be exceeded. The source characteristics assumed for this analysis are presented in Table C-1.

Table C-1. SOURCE CHARACTERISTICS OF A HYPOTHETICAL SEWAGE SLUDGE INCINERATION FACILITY

Building Height	20m (ca. 65 ft)
Height of Roof-Mounted Stack Above Ground Level	23m (ca. 75 ft)
Stack Gas Exit Speed	305 m/min (ca. 1000 ft/min)
Stack Gas Flow Rate	57 am^3/min* (ca. 2000 acfm)
Stack Gas Temperature	32°C (90°F)

Sewage sludge incineration facilities are usually located adjacent to a river, and some are located in pronounced valleys. Thus, the dispersion modeling techniques and relatively restrictive meteorological assumption of a 30-day average wind speed of 2 mps and maximum wind direction frequency of 40 percent used in EPA document APTD-0753[1] are applicable to the present analysis.

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*am^3/min = actual cubic meters per minute.

The only difference between the present analysis and that in APTD-0753 is in the assumed 30-day average "effective" stack height (plume height). In APTD-0753 an effective stack height of 10 meters (equal to the height of the facilities modeled in that document) was assumed. In the present analysis, however, a 20-meter average effective stack height is assumed because of the greater building height and physical stack height at sewage sludge incineration facilities (see Table C-1). That assumption is based on the fact that over a 30-day period the net effect of modest plume rise during light winds and aerodynamic downwash of the effluent during stronger winds will be an effective stack height approximately equal to the building height.

Using the methodology and assumptions in APTD-0753 (with the exception of effective stack height), Figure C-1 was developed. Note that curves are presented for two atmospheric Pasquill stability classes. In general, as noted in APTD-0753, stability C curves apply when large buildings or other major obstructions to the wind cause significant mechanical atmospheric turbulence, such as occurs in major urban areas. In small communities and rural areas, the curves for D stability may be more representative.

There is an important caveat concerning Figure C-1. Close to the source, the indicated allowable emissions curve sharply upward. However, the methodology used in developing those curves does not consider one particular aspect of the downwash phenomenon, viz., downwash of the plume to ground level immediately to the lee

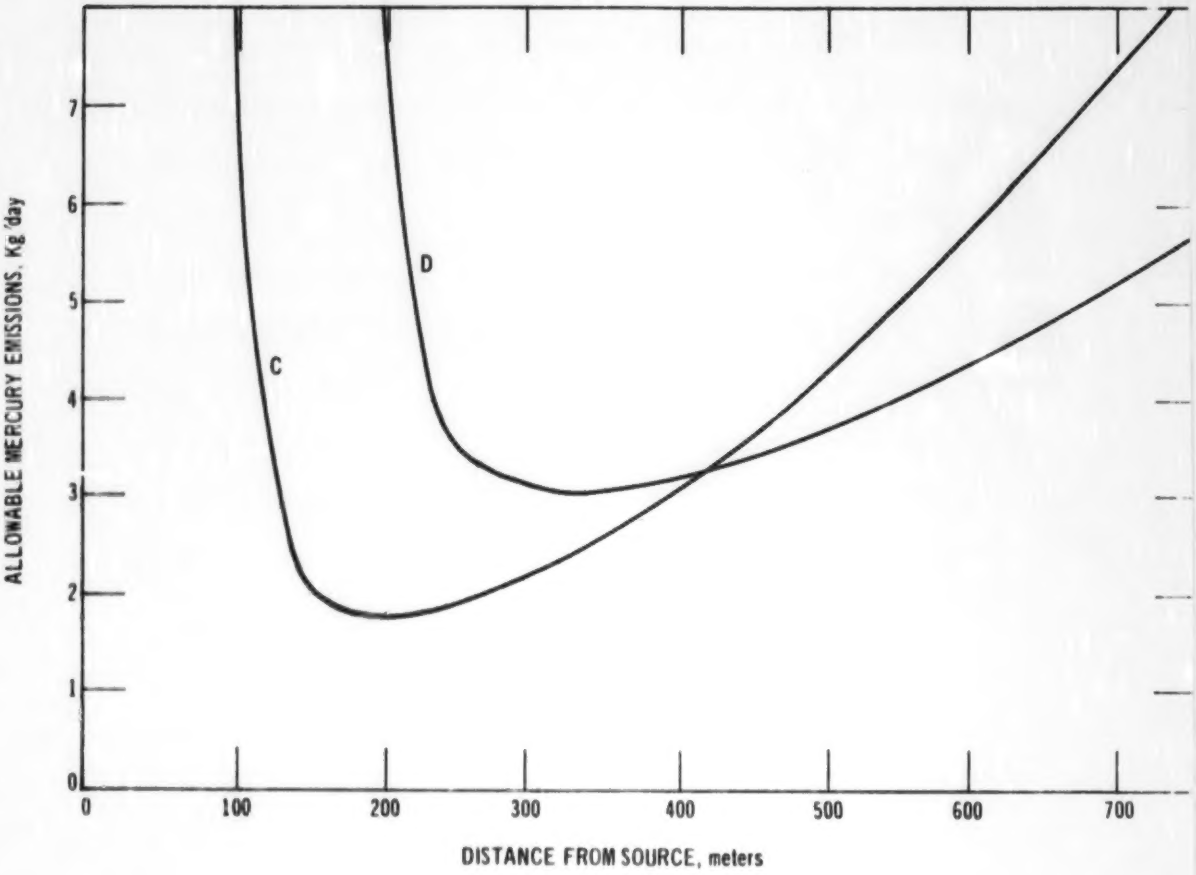

Figure C-1. Calculated maximum allowable mercury emissions from a sewage sludge incinerator un applicable Pasquill stability classes (C and D) and wind speed of 2 mps.

of the building. Thus, emissions will be limited close to the source, even though that is not indicated in Figure C-1. Since the causative factors involved in such a phenomenon (climatology and source characteristics) vary so widely from one source to another, it is impossible to generalize as to how the facilities in the present analysis would be affected.

Designers of sewage sludge incinerators should carefully observe good engineering practices[2,3,4,5] to ensure that the effluent is emitted in such a manner that the frequency with which it is entrapped in eddies and wakes of the structure itself is minimized.

REFERENCES

1. Background Information--Proposed National Emission Standards for Hazardous Air Pollutants: Asbestos, Beryllium, Mercury, Publication No. APTD-0753, Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina, December 1971.
2. Turner, D.B., Workbook of Atmospheric Dispersion Estimates, Publication No. AP-26, Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina, Revised 1970.
3. Briggs, G.A., Plume Rise, AEC Critical Review Series, U.S. Atomic Energy Commission, Division of Technical Information, Oak Ridge, Tennessee, 1969.
4. Smith, M.E., Recommended Guide for the Prediction of the Dispersion of Airborne Effluents, American Society of Mechanical Engineers, United Engineering Center, New York, New York, 1968.
5. Slade, D.H., Meteorology and Atomic Energy, U.S. Atomic Energy Commission, Division of Technical Information, Oak Ridge, Tennessee, 1968.

APPENDIX D. SOURCES CONSULTED DURING STANDARDS DEVELOPMENT

I. Plants Visited

  A. Asbestos

    1. Manufacturers

      a. Johns-Manville Products Corp., N. Billerica, Mass., 8/1/73
      (Asbestos board)

      b. Remington Arms Co., Bridgeport, Conn., 8/2/73
      (Shotgun shell)

      c. Nicolet Industries, Ambler, Pa., 8/29/73
      (Textiles, asbestos board)

      d. Certain-Teed Industries, Ambler, Pa., 8/29/73
      (Asbestos-cement pipe)

      e. Nicolet Industries, Norristown, Pa., 8/30/73
      (Asbestos paper)

      f. Certain-Teed Industries, Riverside, Ca., 9/19/73
      (Asbestos-cement pipe)

      g. Johns-Manville Plant, Manville, N. J., 10/29/73
      (Various asbestos products)

      h. Washington Asphalt Co., Seattle, Wash., 9/73
      (Asphalt concrete)

      i. During the course of previously developing new source performance standards for asphalt concrete plants, 64 asphalt concrete plants were visited.

    2. Fabricators and Distributors

      a. Bird & Son Roofing, Norwood, Mass., 8/1/73
      (Fabricator of asbestos paper (felt))

      b. P. S. Thorsen Co., Boston, Mass., 8/3/73
      (Distributor of asbestos board)

      c. Johnson Construction Specialties, Houston, Texas, 8/16/73
      (Distributor of asbestos cement products)

      d. Kaiser Aluminum, Chalmette, La., 8/17/73
      (Fabricator of asbestos board into molten metal flow control device)

e. Thomas L. Green & Co., Indianapolis, Ind., 8/28/73
   (Fabricator of asbestos board for ovens)

f. Hopeman Brothers, Waynesboro, Va., 8/28/73
   (Distributor of asbestos board for marine industry)

g. Long Beach Naval Shipyard, Long Beach, Ca., 9/17/73
   (Asbestos insulation products)

h. E. J. Bartells, Renton, Wash., 9/24/73
   (Distributor of asbestos products)

i. Pacific Car and Foundry, Renton, Wash., 9/73
   (Fabricator of asbestos textiles)

j. Sun Shipbuilding and Dry Dock, Chester, Pa., 10/26/73
   (Fabricator of asbestos board)

k. Bendix, Auto and Electronic Division, Newport News, Va., 11/7/73
   (Fabricator of asbestos friction products)

l. Wilson & Emerson Construction Co., Cary, N. C., 12/7/73
   (User of asbestos-cement pipe)

m. Sears, K-Mart, and Rigsbee Tire Sales, Durham, N. C., 12/7/73
   (Brake shoe installers)

3. Demolition Sites

   a. Chicago, Ill., 225 E. 35th St., 3/26/74

   b. Chicago, Ill., 36th & Michigan, 3/26/74

   c. Chicago, Ill., 43rd & Calumet, 3/26/74

   d. Chicago, Ill., 63rd & Kenwood, 3/26/74

   e. Chicago, Ill., 63rd & Harper, 3/26/74

   f. Chicago, Ill., 63rd & Stony Island, 3/26/74

   g. Chicago, Ill., 69th & Stony Island, 3/26/74

   h. Chicago, Ill., Taylor & Canal St., 3/26/74

   i. Chicago, Ill., Morgan St. & Fulton Ave., 3/26/74

   j. Chicago, Ill., Orleans St., 3/26/74

- k. Chicago, Ill., Orleans St. (boiler plant), 3/26/74
- l. Chicago, Ill., E. Ernie, 3/26/74
- m. Several other buildings located in and around Chicago area, 2/13/74

4. Waste Disposal Sites
   - a. Lancing, Ill., 3/26/73 (General landfill)
   - b. Nicolet Industries, Ambler, Pa., 8/30/73 (Asbestos waste disposal site)
   - c. Certain-Teed Industries, Ambler, Pa., 8/30/73 (Asbestos waste disposal site)

5. Asbestos Mill Tailings Piles
   - a. GAF Corp., Hyde Park, Vt., 9/10/73
   - b. Pacific Asbestos Co., Copperopolis, Ca., 3/26/74
   - c. Coalinga Asbestos Co., Coalinga, Ca., 3/27/74
   - d. Atlas Asbestos Co., Coalinga, Ca., 3/27/74
   - e. Calidria Asbestos Co., King City, Ca., 3/28/74

B. Mercury

1. Municipal Sewage Treatment Plants
   - a. N. W. Bergen Co., Waldwick, N. J., 11/12/73
   - b. Piscataway, Piscataway, Md., 2/27/74
   - c. Joint Meeting, Elizabeth, N. J., 11/13/73
   - d. Bergen County, Little Ferry, N. J., 11/13/73
   - e. Greensboro, N. C., 12/7/73
   - f. Pittsburgh, Pa., 12/73
   - g. Hartford, Conn., 12/73
   - h. New Haven, Conn., 12/73

        - i. Detroit, Mich., 12/73
        - j. Chicago, Ill., 12/73
        - k. Indianapolis, Ind., 12/73

- II. Tests Conducted
    - A. Asbestos
        - 1. Ambient Asbestos Samples
            - a. GAF Corp., Hyde Park, Vt., 10/9/73 (Asbestos tailings disposal site)
            - b. Nicolet Industries, Ambler, Pa., 10/16/73 (Asbestos waste disposal)
            - c. Certain-Teed Industries, Ambler, Pa., 10/16/73 (Asbestos waste disposal)
        - 2. Asbestos Material Samples
            - a. GAF Corp., Hyde Park, Vt., 10/9/73 (Asbestos tailings disposal site)
            - b. Nicolet Industries, Ambler, Pa., 10/16/73 (Asbestos waste disposal site)
            - c. Certain-Teed Industries, Ambler, Pa., 10/16/73 (Asbestos waste disposal site)
    - B. Mercury
        - 1. Municipal Sewage Treatment Plants
            - a. Stack tests
                - (i) N. W. Bergen Co., Waldwick, N. J., 11/12/73
                - (ii) Piscataway, Piscataway, Md., 2/27/74
            - b. Sludge Samples & Analysis
                - (i) N. W. Bergen Co., Waldwick, N. J., 11/12/73
                - (ii) Joint Meeting, Elizabeth, N. J., 11/13/73
                - (iii) Bergen County, Little Ferry, N. J., 11/13/73
                - (iv) Greensboro, N. C., 12/7/73

(v) Pittsburgh, Pa., 12/73

(vi) Hartford, Conn., 12/73

(vii) New Haven, Conn., 12/73

(viii) Detroit, Mich., 12/73

(ix) Chicago, Ill., 12/73

(x) Indianapolis, Ind., 12/73

III. Meetings

A. Asbestos

1. EPA/Department of Justice/Environmental Defense Fund, 7/9/73
2. EPA/National Association of Demolition Contractors, 9/24/73
3. EPA/National Association of Demolition Contractors, 11/16/73
4. EPA/National Association of Demolition Contractors, 2/11/74
5. EPA/Environmental Defense Fund/Department of Justice, 2/26/74
6. EPA/National Association of Demolition Contractors, 4/17/74
7. EPA/Asbestos Information Association of North America, 3/1/74
8. EPA/National Air Pollution Control Techniques Advisory Committee, Chicago, Ill., 5/22/74
9. EPA Working Group on NESHAP, 5/29/74

B. Mercury

1. EPA/National Air Pollution Control Techniques Advisory Committee, Chicago, Ill., 5/22/74
2. EPA Working Group on NESHAP, 5/29/74
3. EPA/Envirotech, 6/21/74